THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[THIRD SERIES.]

ART. XXX.—*On Cephalization;* by JAMES D. DANA. Part V. *Cephalization a fundamental principle in the Development of the System of Animal Life.*

THE principle of cephalization has been explained at length in memoirs in former volumes of this Journal,* and to them I would refer for detailed illustrations of the subject. Among these illustrations the attention of the reader is especially called to those from the department of Crustacea, the study of which—occupying more than half of my time between the years 1837 and 1855—brought before me the facts on which it rests. It cannot fail to be perceived, in the review, that, with elevation in grade among the Decapods, for example—passing upward along the line of Macrural forms to the Brachyural (or from the lowest of shrimp-like species to crabs)—there is in general, with the rising grade, an abbreviation relatively of the abdomen, an abbreviation also of the cephalothorax and of the antennæ and other cephalic organs, and a compacting of the structure before and behind; a change in the abdomen from

* For former papers on Cephalization, see this Journal, II. xxii, 14, 1856; xxxv, 65, xxxvi, 1, 159, 321, 440, 1863; xxxvii, 10, 157, 1864; xli, 163, 1866.

One point made in these papers, I would withdraw, viz: that the transfer of the anterior pair of members in Man from the locomotive to the cephalic series is analogous to the transfer which takes place in Crustaceans in passing from the Tetradecapod to the Decapod type, or from the Arachnoid to the Insect type. The latter is plainly a structural transfer, the two anterior pairs of limbs in the Crustacean, or the one in the Insectean class, becoming, by the transfer, strictly cephalic organs (pertaining to the mouth series), and existing thus in a large tribe of species. But in man it is properly only a functional transfer, analogous to cases among spiders and Tetradecapods, where the anterior legs become adapted to serve functionally the mouth or head, without that structural transfer which would place them of itself in the higher order.

an organ of great size and power and chief reliance in locomotion, to one of diminutive size, and no locomotive power; and a change as to the particular pair of legs which is the strongest, from one of the more posterior to the anterior in the series; in other words, that, as grade rises, there is abbreviation behind and before, and thus a concentration of the structure, and a more forward or anterior position in the stronger of the organs of locomotion and prehension. The shrimp and crab are so widely unlike in form that the common eye hardly suspects that they are made up of the same parts or organs arranged in precisely the same order: that the latter is only a shrimp contracted in length, dwindled to almost nothing in its abdomen, and compacted in its mouth organs so that the outer pair makes a well fitting operculum over the others, and shortened in its very long multiarticulate antennæ to a few articulations giving them a length often not a tenth of that of the cephalothorax.

I would refer also to the case among mammals, for an illustration of the same principle—that the lowest forms are those having their locomotive functions located in the posterior parts of the body;* and that in the higher, the forces, or force-organs, are more and more forward in the structure. For example, in the whale—the tail is the propelling organ and is of enormous power and magnitude, and the brain is very small and is situated far from the head extremity in a great mass of flesh and bone furnished with poor organs of sense; a grade up, in the horse or ox, the tail or posterior extremity is no longer an organ of locomotion, and is little more than a caudal whip-lash, and locomotion is performed by organs situated more anteriorly, the legs, and a well-formed head carries a brain which is a vastly higher organ of intelligence than that of the whale—but the legs are simply organs of locomotion, and the hinder are the more powerful; and higher up, in the tiger or cat, the fore-legs—not the hind-legs—are the organs of chief muscular force, and these have higher functions than that of simple locomotion, and, further, the body is proportionally shortened, and the head is shortened anteriorly or in the jaws and approximates thus toward the condition in man. The existence or not

* The fact that fishes have, with few exceptions, the tail as the chief or only locomotive organ, corresponds with their inferior position among Vertebrates. At the same time, it makes the application of the principle of cephalization in determining grade among them quite difficult. In most classes or groups the force-organs constitute a series along the body, and the position of the strongest, and the transfer forward with the rise in grade, is openly manifested. But in nearly all fishes, the tail remains the locomotive organ, with no transfer of its locomotive function to more anterior members, and, therefore, other less obvious and much less certain modes of determining any forward transfer of force are all that remain. And, further, as the conclusions we may arrive at hold good, among all classes of animals, only in case *other conditions in the structure are essentially equal*, the inferences from such evidence can ordinarily extend only to the grade in the family or smaller group to which the species belong.

of a switch-like tail, as in ordinary quadrupeds, has little bearing on the question of degree of cephalization, since the organ is not an organ of locomotion, or one indicating a large posterior development of muscular force. But, approaching man in the system of life, even this seems to have significance.

In accordance with the principle and method illustrated, animals of a given type differ widely as to the conditions and arrangements for action—muscular, sensorial and psychical—in the animal structure. In the low,* there is, usually, large size and strength behind, an elongation of the whole structure, and a low degree of compactness in the parts before and behind; in the high, there is a relatively shorter and more compacted structure, a more forward distribution of the muscular forces or arrangements, and a better head; and the progress in grade, under a type, is progress along lines from the former condition toward the latter, that is, progress in the strength, perfection and dominance of the anterior or cephalic extremity; in a word, it is progress in cephalization.

The principle of cephalization is thus fundamental because, first, the chief center of nervous power or energy in an animal is at the cephalic extremity; and, secondly, because form in nature's species is, with some limitations, an expression of force.*

Again, I have exemplified, in my memoirs, the corresponding fact that progress in cephalization generally attends progress in embryonic development; referring, for illustration, to the loss of the locomotive tail in the frog and many other Amphibians at the time of the passage to the adult stage, and the concurrent development anteriorly of limbs, with the perfecting of the head in structure and senses; to a similar abbreviation posteriorly in the development of modern gars; to the fact that the higher insects rise from a state that is worm-like in form, having no distinction of thorax and abdomen and sometimes furnished with abdominal locomotive appendages, to an adult stage in which the abdomen is greatly dwindled in size, the thorax and abdomen are distinct segments and the former alone has locomotive members and these of perfected structure, and the well-defined head has highly developed sense-organs and exalted senses; and to other examples, all illustrating the view that through the developments going forward in the progress of embryonic development, there may in general be distinguished a cephalization, or forward improvement, of the structure.

It has also been illustrated that the geological progress in the life of the world has been progress in accordance with the principle of cephalization, this being manifested in the succession of forms under the various types, and also in the correspondence

* For a consideration of the inferior species of some groups, related to half-developed embryonic forms in structure, I would refer to my former papers.

so often exhibited in a general way—as announced by Agassiz—between the biological succession and embryonic development. I need not dwell on the facts in this place, as they are well understood.

Professor Marsh has recently brought forward facts which exemplify fully the view that the succession in the animal life of the globe has been more or less connected with brain-progress, facts which sustain strongly the doctrine, which I have elsewhere urged, that this progress involved changes in structures in obedience to the principle of cephalization.*

Professor Marsh states† that in the Eocene Dinoceras, from the Rocky Mountain region, the brain was not more than one-eighth the bulk of that of the modern Rhinoceros—its nearest recent ally; in the Miocene Brontotherium it was much larger, about equalling that of the Indian Rhinoceros: and in a Pliocene Mastodon, the brain was larger than in Brontotherium, but not equal to that of living Proboscidians. In a paper on the Eocene Coryphodon of the same region,‡ the brain was even lower than in Dinoceras. Again, after a further study of the subject,§ and a comparison of an extensive series of ancient and modern crania, he gives as his conclusions—in advance of a full and illustrated memoir on the subject: "*First*, all Tertiary Mammals had small brains; *second*, there was a gradual increase in the size of the brain during the age; *third*, this increase was mainly confined to the cerebral hemispheres, or higher portions of the brain; *fourth*, in some groups the convolutions of the brain have become more complicated; *fifth*, in some, the cerebellum and olfactory lobes have even diminished in size;" and, further, "there is some evidence that the same general law of brain-growth holds good for birds and reptiles from the Cretaceous to the present time."

A growth of eight fold in bulk since the early Tertiary is enormous, vastly exceeding in amount the growth in other organs; in fact, the species related to the Rhinoceros have not increased in bulk with the progress of time, but diminished. And the same is true of other species; there is in general higher grade *with smaller bulk*. Moreover, concurrently with the change in the brain, there has been in succeeding species a relative shortening of the head and especially of the jaws, besides other modifications, such as mark a rising grade of cephalization.¶

* Author's Manual of Geology, 1874, p. 596.

† This Journal, III, viii, 66, 1874, and xi, 163, with figures of the Dinoceras brain; xi, 335, with figures of the brain in Brontotherium; and xi, 425, with figures of the brain in the Eocene Coryphodon.

‡ Ibid., xi, 425, 1876. § Ibid., xii, 61, July, 1876.

¶ The jaws are in some mammals relatively short through the incisor portion being imperfectly developed, and this condition is a mark of inferior grade. The shortening referred to above is not of this degradational kind, but that presented in a diminished distance between the normal incisor-extremity and the normal position of the posterior molar—an abbreviation which reaches its extreme limit in man.

But have other peculiarities of the later species any connection with this growth and change of brain? We can hardly doubt, that, inasmuch as there has been no corresponding change in the animal's bulk, there must have been concordant changes somewhere, and change of equal magnitude and importance; and the supposition that they included the structural modifications which mark the line of species from the early Tertiary onward, does not appear to be extravagant.

Such growth or progress in the brain and nervous system—the seat of power in the animal—is accordant with, and consequent upon, the great fact that this is the part of the structure which comes into actual contact with outside and inside nature. It is the means in an animal by which communication is had with the outer world and also with its own inner workings and appetites; that which takes impressions, which feels whatever inspires energy, prompts to action, exhilarates, or exalts; the part, therefore, which must grow whenever circumstances favor progress, and, at the same time, fail to grow or dwindle under unfavorable circumstances; which communicates whatever it receives to the being to which it belongs, and, in each case, to the part or parts responding to its condition; which reaches every part of the system and dominates in all action and growth, and hence must cause an expression of its own condition in some way on the structure; which, moreover, must ordinarily produce correlate changes in correlated parts, if any, because in its own nature and distribution the system of correlation has a full expression. Energetic use gives increasing strength to muscle; and that wonderful strengthening growth in the brain since Eocene times may also have come from use.

It would hence appear that a prominent means of change in species is the action of influences on the brain; that the brain grows and changes and sends its changing forces through the animal; and that this gives progress, or degradation; and hence it is that progress is exhibited in cephalization, and degradation in decephalization. The brain could not grow to the adult stage in the frog without the change in the structure that cotemporaneously takes place; and no more could the brain of a species like a shrimp grow into a brain of the higher grade of a crab without its determining in some sense a concordant higher grade of structure in the animal, involving the loss of locomotion in the abdomen and also other changes.

We recognize, as evidence of upward progress in Man, an increasing height, width and erectness of the forehead, and a shortening of his jaws, and see therein evidence of improved intellect; which means higher grade of cephalization. But, more than this, the erect form of Man, the shortened arms, the naked skin, as well as the large, smooth-surfaced cranium, may

also be as directly and necessarily connected with, and dependant upon, his superior degree of cephalization in the system of animal life; while the hairy skin, the long arms, the crested skull, the inclined posture of the man-ape, may be all involved in the ape's inferior degree of cephalization. If so, the development of the brain in Man and of all the highest structural perfections of the Vertebrate type which he exhibits is inconsistent with the existense of the hairy covering and some other circumferential as well as interior characteristics of the brute.

We may therefore believe that in all progress in grade, upward or downward, there was involved some changes in the animal structure of the kind expressing degree of cephalization. Brain-progress could not have taken place without structural progress: and with the brain eminently the growing organ, the brain-progress would have had a determining relation to the latter. More than this, many peculiarities of form or structure in animals which are not evidently marks of grade in cephalization, or have little or nothing to do with it, may have had the same source. The type of structure characteristic of a group of species is beyond doubt connected with some peculiarity of chemical composition, or rather of chemical compounds present, in the great center of activity; and this chemical condition once established, the progress afterward, connected with brain growth or change, might well be a development in that line of type structure, displaying the type under new forms.

I do not mean to imply, in the above, that the method of progress pointed out accounts for the existence of the various types of structure in the animal kingdom, or for all the developments under them; but only that, whatever the types of structure in course of development, there was also a general subordination in the changes to the principle of cephalization; because the nervous system by its growth and domination must necessarily have determined such subordination; and, further, that, through the same agency, the development of other peculiarities of structure and form, not obviously marks of grade, may have been occasioned. The origin of the grander types of structure must be connected with the profoundest of molecular laws; and how connected, man may never know.

These views may hold whatever be the true method of evolution. The method by repeated creations through communications of Divine power to nature should be subordinated, as much as any other, to molecular law and all laws of growth; for molecular law is the profoundest expression of the Divine will, the very essence of nature; and no department of nature is without its appointed law of development. But the present state of science favors the view of "progress through the derivation of species from species, with few occasions for Divine

intervention."* If then there has been derivation of species from species, we may believe that all actual struggles and rivalries among animals, leading to a "survival of the fittest," must tend, as in Man, to progress in cephalization, and dependent structural changes. In fact, mere living, the surmounting of the daily obstacles in getting food and shelter and satisfying ordinary desires, may have given growth to the brains and structures of the Eocene mammals, aiding, but perhaps exceeding, all other influences from environments.

The source of variation here pointed out is not at all at variance with Darwinism. Darwin, in fact, does not aim to explain the origin of variation among species, but chiefly the workings of natural selection—variations being in progress by some means—in leading to the "survival of the fittest" of the varieties. Variation he refers to environments, and especially to action on the genital system. The genital system may have this prominence in plants; but for animals I would give the *nervous* system the higher place, inasmuch as upon it environments make their first and most powerful impress.

One reason why plants present but few simple types of structure compared with animals, and why marine plants are almost the same for all geological time, and thus strongly contrast with the immense diversity and complexity of types and kinds among marine animals, may be found in the fact that plants possess not that feeling, knowing, outreaching and inworking thing, a nervous system. This, however, is not all: for the presence of so large a proportion of nitrogen in the animal structure, in addition to other elements, gives an opportunity for a vastly wider range of chemical combinations.

ART. XXXI.—*On an Electro-magnetic Machine constructed at the Cornell University Workshop;* by WM. A. ANTHONY, Professor of Physics at the Cornell University.

THIS machine is essentially the same as the "Gramme" electro-magnetic machine, and its construction was undertaken on account of the difficulty that seemed to exist in the way of procuring the "Gramme" machine from the European manufacturers.

The soft iron core of the revolving armature consists of a coil 24 cm. external diameter, 20 cm. internal diameter, and 15 cm.

* This sentence is cited from my Manual of Geology, 1874, p. 603. After it come these words:—"For the development of Man, gifted with high reason and will, and thus made a power above Nature, there was required, as Wallace has urged, the special act of a Being above Nature, whose supreme will is not only the source of natural law, but the working force of Nature herself," and this I still hold.

wide, of very soft iron wire 3 mm. *square*. To prevent, as far as possible, the formation of induced currents in the coil itself, which would consume power to no purpose, the wire, while being wound into the coil, was drawn through a thick shellac varnish, which, it was thought, would to a certain extent insulate the adjacent wires from each other.

The conducting wire of the armature consists of 100 coils, each of 4 meters, of cotton-covered copper wire 2 mm. square. These coils terminate alternately on the right and left of the armature, and each set is connected with fifty copper strips which surround the axis and serve to transmit the current in the usual way. The two sets of coils are entirely independent of each other, and constitute practically two distinct armatures. The resistance of each armature as employed in the machine is very nearly $\frac{1}{4}$ of an ohm.

The cores of the two inducing magnets are 7·5 cm. diameter, 60 cm. long. At the middle of each is a block of cast iron which serves as the magnetic pole, 15 cm. wide, and embracing about one-third of the circumference of the armature. On each end of the cores is a bobbin 25 cm. long and 15 cm. diameter, wound with eight layers of copper wire 3·5 mm. square. The eight layers are not joined on the bobbins, but form so many independent conductors, the terminals of which are carried to a commutator on the base of the machine. The commutator serves to combine the wires into one continuous conductor having a resistance a little less than one ohm, or into 4, 8 or 32 conductors in multiple arc.

The wires from the four brushes which collect the currents from the armatures are carried to another commutator, which serves to join the two armatures in series or in multiple arc with the coils of the inducing magnet in the main circuit, or to put one armature in circuit with the magnet coils, while the other communicates with the terminals of the machine and furnishes the useful current.

Preparations were commenced for making a complete series of tests of the working of the machine, but it had been decided to send the machine to the Centennial exhibition, and, as the preparations could not be completed in time, only a few tests were made. Large German-silver wires were stretched across the room to serve as resistance, as described by Professor Pickering in his account of the tests of the Farmer machine at the Institute of Technology in Boston. For measuring the currents, a tangent galvanometer was especially constructed, and its constants determined from a large number of experiments with the copper voltameter.

The tables below give some of the results of the experiments. The observations and computations were made under my direction, principally by Mr. M. M. Garver, now a graduate of this

University in the department of Chemistry and Physics. More extended tests will be made after the machine returns from the exhibition, when a dynamometer will be procured to measure the power consumed.

TABLE I.

Armatures joined in series; resistance $\frac{1}{4}$ ohm.
Magnetic coils joined in series; resistance 1 ohm (nearly).

No. of revolutions per minute.	E. M. F. Volts.	Total resistance. Ohms.	Current. Webers.
543	68·9	6·74	10·22
572	54·05	11·06	4·91
560	5·17	141·5	·0364
419	36·85	11·06	3·35

TABLE II.

One armature supplying the useful current, the other in circuit with magnet coils which were joined in series.

No. of revolutions per minute.	E. M. F. Volts.	Total resistance of useful circuit. Ohms.	Useful current. Webers.
323	24·1	4·39	5·49
319	23·8	3·67	6·50
313	23·34	2·82	8·27
309	23·28	2·65	8·78
309	23·17	9·81	2·36
309	25·1	19·19	1·31
309	25·8	62·95	·40
279	18·7	62·95	·30
279	16·6	2·82	5·88

Only one experiment with the armatures in multiple arc was performed, and in this, a water voltameter, having platinum plates 6 x 8 cm. enclosed in separate tubes to deliver the two gases separately, was included in the circuit. The magnet coils were joined to give four circuits in multiple arc, having a resistance altogether of $\frac{1}{16}$ ohm. The resistance of the armatures in multiple arc is $\frac{1}{8}$ ohm. Hydrogen gas was delivered at the rate of 257 c.c. per minute, which corresponds to a current of about 43 Webers. The speed in this experiment was not recorded, but could not have been far from 320 revolutions per minute. I speak of the experiment only to show the range of adaptability of the machine.

A series of experiments was made to determine the character of the light produced by the machine, with the following general result:

Number of revolutions per minute,	487 to 525.
Current by galvanometer,	10·5 to 11·5 Webers.
Resistance of light, about	4 ohms.
Entire resistance,	5·65 ohms.
Intensity of light (average),	1600 candles.

The intensity of the light was determined by first comparing it with that of a coal-oil lamp and then comparing the latter with a standard candle.

In all these experiments the machine was driven by a five horse power oil engine, known as "Brayton's Ready Motor," built by the "New York and New Jersey Ready Motor Company." An interesting fact appeared upon comparing the oil used by the engine with that consumed by the lamp used for comparison with the electric light. The lamp had a flat wick one inch wide. This was carefully trimmed and the light carefully adjusted before the experiments. The experiments continued four and a half hours, during which time the lamp burned continuously. The lamp consumed per hour 29·8 grms. of oil. The electric light was equivalent to 234 lamps, that is, equivalent to the light produced by the combustion of 6973 grms. of oil per hour. The engine consumed three kilograms of a light gravity crude petroleum per hour.

It would seem, therefore, that the combustion of the oil in the engine produces, after the transformation of the energy evolved, first into mechanical power, then into the electric current, and lastly into light, nearly three times as much light as when consumed in the ordinary lamps.

I would add that, while the machine produces a very efficient light, which I have used with great satisfaction in my lectures, it is not so well adapted as it might be to this particular purpose. The electro-motive force developed is too small, and the internal resistance of the machine too small, for the best effect with the light. The small resistance of the machine makes the regulation of the light difficult. (The regulator used was the Foucault.) For, the light being about two-thirds the resistance of the circuit, any change in the relative position of the carbons, changes materially the entire resistance, and this, since the coils of the inducing magnet are in the main circuit, makes a very great difference with the current.

To make a more perfect machine for the production of the light and retain the advantages it now possesses for other purposes, it is proposed to construct a new armature, using finer wire and a greater number of coils, and connect the terminals of these with a commutator that will permit them to be joined in series as usual, or in multiple arc in groups of two or three, these groups being joined in series as though they were single coils. Such an arrangement will produce a machine which can be readily adapted to the various conditions of external resistance met with in electrical experiments.

Physical Department, Cornell University, Ithaca, N. Y., July 24, 1876.

ART. XXXII.—*On the Sea-bottom Deposits observed during the Cruise of the Challenger in a report to Prof. Wyville Thomson;* by JOHN MURRAY, Esq., naturalist of the expedition.*

THE kinds of deposits obtained in soundings by the Challenger, may for the present be classed under the following heads:—

1. *Shore-deposits.*
   (*a*) Blue and green muds.—Met with near the shores of most of the great continents and islands.
   (*b*) Gray muds and sands.—Met with chiefly near oceanic islands of volcanic origin.
   (*c*) Red mud.—Met with on the eastern coast of South America.
   (*d*) Coral-mud.—Met with near coral reefs.
2. *Globigerina-ooze.*—An abundant oceanic deposit not met with south of latitude 50° S.
3. *Radiolarian ooze.*—An oceanic deposit met with only in the Western and Middle Pacific.
4. *Diatomaceous ooze.*—An oceanic deposit met with only south of 50° S. latitude.
5. *Red and Gray Clays.*—The most abundant oceanic deposit.

The above names have been selected as indicating those elements which give the predominating character of the deposit. As a rule, when the débris of continents or islands, the dead shells of Foraminifera, the exuviæ of Radiolarians, etc., the frustules of Diatoms, or red or gray clayey matter—when any of these have appeared to make up considerably more than one half of the specimen under examination, it has been called a shore-deposit, a Globigerina, Radiolarian, or Diatom ooze, or red or gray clay.

Sometimes it has been doubtful whether a specimen should be placed under one of the above heads or another, on account of the nearly equal ratio of constituents, or where one deposit overlies another of a different kind. In these cases the specimen has been placed under that head with which, on a general view, it has seemed to have most in common, or to which the surface-layer belonged, and a detailed description has been added in the list.

A sixth kind of deposit or formation might have been added, to embrace those bottoms in which a great quantity of the *peroxide of manganese* occurs. This substance, in the form of

* From the Proceedings of the Royal Society, vol. xxiv, No. 170. The general remarks here cited are preceded in the Report by detailed descriptions of each of the soundings in the course of the expedition. These notes and conclusions are from a preliminary report, which is soon to be followed, now that the expedition has returned, with a fuller statement.—EDS.

nodules or concretions, of incrustations or in grains, has been found in nearly all sea-deposits and at all depths in more or less abundance. However, for the present it has been considered best to treat of its occurrence separately, at the same time pointing out those regions where we have found it in greatest abundance.

A few remarks may now be made upon each of the kinds of deposits indicated.

1. *Shore-deposits.*—It has been found that the deposits taking place near continents and islands have received their chief characteristic from the presence of the débris of adjacent lands. In some cases these deposits extend more than 150 miles from the coast. Several varieties can be recognized among these shore-deposits.

(*a*) *Blue and Green Muds.*—In the great majority of cases the deposits near continents and large islands, containing the older and crystalline rocks, have been of a blue or green color; the only exception appears to be the east coast of South America, where we have a red mud, to be presently referred to.

In from 100 to 700 fathoms these deposits are often of a green color, due to the presence of a green amorphous clayey matter, and dark and pale green glauconite particles. Beyond 700 fathoms they are usually of a blue or dark slate-color, having a thin upper layer of a red or brown. This red layer is a soft ooze, whilst the blue mud or clay beneath is very compact and tenacious. Much amorphous clayey matter and fine particles of mica, quartz, and other minerals are found in all these deposits, the mineral particles increasing in size as we approach the land.

Down to 1500 fathoms, we have generally found that Pteropod, larval Gasteropod, and Lamellibranch shells were tolerably abundant, and that there were many of the shore forms of Foraminifera, as Textularias, Rotularias, Nodosarias, Uvigerinas, Lagenas, etc. Pelagic Foraminifera occur throughout the deposit, but not in such abundance as in a true ocean-deposit. The frustules of Diatoms and their broken parts are numerous. Manganese grains are found in many of the bottoms, usually in the deeper soundings. We have also found imbedded in these muds pieces of wood, fruits, portions of fruits, and leaves of trees. Large pieces of rock, as pumice and granite, and rounded pebbles also occur. Our soundings near the southern ice-barrier were muds of a blue color, containing many granitic and other pebbles and blocks, mostly rounded, and many Diatoms, and resembled in most respects the deposits we found off the east coast of North America, Halifax to New York.

Beyond 1500 or 1700 fathoms, Pteropod and Heteropod shells are usually not found, and in 3000 fathoms hardly a Foraminiferous or other carbonate-of-lime organism remains.

Siliceous organisms occur at all depths, but at times their remains would seem to be completely removed.

These green and blue muds have been found to prevail in all the enclosed seas we have visited, as Arafura, Banda, Celebes, and China seas, Inland Sea of Japan; and in all these the carbonate-of-lime organisms would appear to be removed from the bottoms in depths less by some 400 or 500 fathoms than on open coasts.

In the green muds from 50 to 700 fathoms we have found those beautiful casts of Foraminifera, Pteropods, *Echini*-spines, and other carbonate-of-lime organisms, frequently in great numbers. These are of a dark green, pale green, and dirty white color. In all cases where these green internal casts occur we have many glauconite grains in the bottom. Beyond 700 fathoms these casts seldom occur, and when they do they are very sparingly distributed; and the same may be said of the glauconite grains which accompany them. River-muds, in which Pteropods, Radiolaria, and pelagic Foraminifera are usually wanting, are included in these deposits.

The following are the localities in which we have found the blue muds (an asterisk before the locality indicates that glauconite casts and grains have been found there):

* Off coast of Portugal; off Virgin Islands (?); * off coast of North America, Halifax to New York; off Guinea, coast of Africa; * off Cape of Good Hope: off Antarctic ice-barrier; * off Australia; * off New Zealand; * off New Guinea and Phillipines, and throughout the seas of the East-Indian archipelago; * off Japan; off east coast of South America.

The following are the depths of the soundings which have been placed under this head:—

Blue Muds.

fms.	fms.	fms.	fms.	fms.	fms.	fms.
1125	600	2020	1300	40	2100	2000
1290	3875	1750	2200	32	700	1075
1475	2425	2500	400	1100	90	2250
1380	1700	2325	150	700	150	20
1800	1240	1250	140	2800	375	2675
1000	1350	1675	75	1425	2225	1875
525	1340	1800	39	2550	2050	2225
900	1250					

Green Muds.

fms.	fms.	fms.	fms.	fms.	fms.	fms.
470	100	120	400	580	705	245
560	150	650	10	129	185	565
80	2200	950	70	255	37	775
75	290	1200	800	100	152	

(*b*) *Gray Muds and Sands.*—Near volcanic islands we have found that the deposits have a distinctive character, from the presence of the débris of volcanic rocks. The presence of pieces of pumice, scoria, etc., prevents this deposit having that clayey character so characteristic of the blue mud. The color is generally gray, but occasionally is a black sand or a more or less slate-colored mud. In some places the shells of oceanic organisms make up a large part of these muds.

Down to about fifteen hundred fathoms we have Pteropod, Heteropod, and surface Gasteropod shells, and the shore forms of Foraminifera are common. Deeper than 1500 fathoms, Pteropod shells are rare or entirely removed. Pelagic Foraminifera are found at all depths; but occasionally they and the siliceous organisms are quite absent at a depth of little over 2000 fathoms, and then we have a clay or mud with many small particles of pumice, scoria, etc. Manganese appears to be intimately associated with some of these bottoms, especially where the débris of augitic lavas are present, as at Sandwich Islands, Canaries, and elsewhere. Off the Desertas, in 670 fathoms, all the dead shells, pieces of Polyzoa, etc. had a slight coating of this substance, and we have had indications of the same thing in even less depths. In 1100 fathoms off the Canaries some pieces of shell had rather a thick coating; and in 1575 fathoms, not far from this place, the dredge brought up a great quantity of a Gorgonoid axis deeply imbedded in or coated with this black oxide of manganese.

In some localities this deposit extends to a great distance from the islands, as at Hawaii, 200 miles or more.

The following are the depths of the soundings which we have classed as

Gray Mud.

fms.	fms.	fms.	fms.	fms.	fms.	fms.
670	7	1000	260	20 to 100	2150	2650
1150	640	1125	360	75	2600	1525
930	1750	1070	1100	520	1050	420
1500	620	1000	50	630	500	590
278	1890	1675 (?)	150	600	2050	620
630	1525	465	600	1200	2875	680
560	450	675				

Occasionally a few casts of the Foraminifera have been observed of a red color. These were usually very rough, and had not the delicate hues of the green glauconite casts. One very remarkable exception occurs:—off the Crozets there were (in 600 fathoms) many beautiful casts of the carbonate-of-lime organisms of a pale straw-color. None of the glauconite grains were noticed in the same sounding or locality.

(*c*) *Red Mud.*—It has already been stated that the deposit

along the east coast of South America, from Cape San Roque to Bahia, differed from the deposits found along the shores of other continents and large islands in being of a red color. There can be little doubt but that this red color is due to the presence of the ochreous matter carried into the Atlantic by the South American rivers. There are reasons for thinking that the red color of some of the deep-sea clays in this region of the Atlantic may have a like origin.

The soundings near the shore and in shallow water have a deeper red color and contain larger mineral particles and fewer organic remains than those farther from land and in deeper water. The mineral particles are chiefly quartz and mica.

In all these soundings there are many pelagic and other Foraminifera, Heteropod, Pteropod, larval Gasteropod, and Lamellibranch shells, Coccoliths, and Rhabdoliths. Siliceous organic remains, as of Diatoms and Radiolaria, are almost quite absent in these bottoms. In some of the shallower depths a few red-colored casts of Foraminifera were observed; but these were rare, rough, and more or less imperfect.

The following are the depths of the soundings along this coast:—

fms.	fms.	fms.	fms.	fms.
1375	1650	32	1600	1015
500	675	400	1200	1275
2050	120	1715	700	2150

(*d*) *Coral-Mud.*—This is a deposit found in the neighborhood of coral reefs. It is characterized by a large quantity of amorphous calcareous matter, by the débris of coral reefs, by many large calcareous forms of Foraminifera, and by broken pieces of Polyzoa, etc. All the deposits about Bermuda are of this nature, extending from the edge of the reef down to a depth of 2500 fathoms. At 1000 fathoms the mud assumes a rose tinge; this deepens into a red color with greater depth, and the accompanying decrease of carbonate of lime and increase of clayey matter, until the coral-mud merges into the red and gray clays of the surrounding ocean. About Bermuda very few mineral particles were found. In some of the soundings to the S. W. of the island there were some small pieces of a green rock like those at St. Paul's Rocks, and probably serpentine. One or two pieces of quartz, or sanidin, a piece of mica, and a small piece of pumice (?) were also noticed. Dissolving away carbonate of lime in some of the shallower soundings only a trace of clayey matter remained with a perceptible rose tinge. No casts of the Foraminifera were noticed about Bermuda.

At the Virgin Islands, at Tongatabu, at Fiji Islands, at Cape York, Admiralty Islands, Honolulu, and Tahiti we also met with coral-muds. Except at Cape York, these muds appeared

to exist as a narrow band around the land, and had usually a considerable admixture of clayey matter and mineral particles. Where there was much clayey matter we found usually a few rough red casts of the Foraminifera.

The following is a list of the depths of the soundings included under coral-muds :—

At Bermuda.			At other places.		
fms.	fms.	fms.	fms.	fms.	fms.
2250	2100	1250	460	140	25
1820	1950	1575	390	210	100
950	2650	1500	625	610	40
430	1325	200	18	70	90
1375	1075	37	240	25	100
2450			315	16	
			255		

2. *Globigerina-ooze.*—After the deep-sea clays, this is the most abundant deep-sea deposit. It has occurred at all depths from 250 to 2900 fathoms. The *Globigerinæ*, which give at once the name and chief characteristic to this deposit, are really found all over the bottom of the ocean. Even in our deepest clays, if the surface-layers be selected and all the amorphous matter be washed away, one or two shells of some variety of pelagic Foraminifera can usually be detected. By pursuing this method I have failed only on one or two occasions. They appear to be quite absent in the Arafura Sea. It is, however, when they occur in vast numbers that they form the deposit known by this name; at least such is the sense in which it is here used. We did not find a Globigerina-ooze in any of the enclosed seas, in the Southern Ocean south of lat. 50° S., nor in the North Pacific north of latitude 10° N.

In the Southern Ocean only one small species of *Globigerina* was found in the surface-waters; but in the North Pacific many varieties of pelagic Foraminifera abound near the surface of the ocean. In other parts of the preceding oceans, and in the other oceans we have visited, it occurs in irregular patches, being always present in the open ocean when we have depths of less than 1800 fathoms. Its presence or absence at depths beyond 1800 fathoms is, however, determined by conditions at present unknown. A number of varieties occur both as to color and composition. Some specimens are nearly pure white, others have a rose-color, and others are red or dark brown. The red and brown color arises from the presence of the oxides of iron and manganese. In the white varieties the sediment, after dissolving away the carbonate of lime, is in some specimens abundant, in others not abundant, and is either of a red or slate-blue color. We find the former color to prevail in those soundings

far from continents and large islands, and the sediment is not abundant except where pumice or scoria is present. The latter, or slate-blue color, is found in those soundings more or less near continents and large islands; and it is suspected that this sediment has its source chiefly from the disintegration of these adjacent lands.

Mica, quartz, pumice, scoria, and other mineral products are met with; but in those soundings farthest from land a little piece of pumice or scoria may be the only trace of mineral particles.

In some specimens there are very many remains of organisms with siliceous shells, as Radiolaria, Diatoms and Challengerias; but in others these remains are almost entirely wanting. In three soundings in mid-Atlantic, between the Canary and Virgin Islands, and in several soundings in the South Pacific, manganese in the form of grains and nodular concretions is very abundant. As a rule, however, this substance occurs rather sparingly in Globigerina-ooze. In some instances we get little nodules of these bottoms, the shells as it were being run together by a siliceous cement. Many small pieces of chert-like mineral also occur, which are angular and soft, and do not look as if they had been transported. Manganese nodules occurring in the Globigerina-ooze have often a nucleus of a yellow and green color, in which Globigerina-shells can be seen; but their carbonate of lime has been entirely removed, and replaced by a silicate. There are reasons for thinking that these indications of flint (?) occur only in those samples where the siliceous shells of Radiolaria, Diatoms, etc., are wanting, and do not occur where these organisms are present. A reëxamination of all the bottoms must be made before this statement can be definitely affirmed. Casts of Foraminifera occur very sparingly in Globigerina-ooze; in the purest samples not at all. In those with an admixture of clayey matter we have frequently one or two partial casts of a very rough character. In two soundings, Nos. 211 and 301, in the Pacific, we found the Foraminifera not only filled, but also coated, with a red substance, so that we had both an internal and an external cast, the two being connected by little rods representing the foramina of the shell. In these soundings there was much clayey matter and disintegrating pumice and scoria.

In a few soundings in the Pacific, as No. 304, we have had a Globigerina-ooze on the surface of the bottom, and a foot beneath a nearly pure red or brown clay. Again, as in Nos. 268 and 307, we have the reverse arrangement, a clay occupying the surface, and the deeper layers having many *Globigerinæ*. In all these cases the surface-layer has been normal with the

other soundings in the same region as to depth. In the first case we might bring in elevation to account for the Globigerina-ooze overlying the red clay, or we might suppose that chemical changes are going on in the deeper layers which remove the carbonate of lime. In the second case we may account for a red clay overlying a deposit with many *Globigerinæ* in it by supposing a depression of the bottom after the latter had been laid down; or we may believe that agencies are now removing carbonate of lime from the surface-layer, and that these were not active in some past time.

This deposit occurs, in one sounding, in the Pacific at a depth of 2925 fathoms in mid-ocean. In the eastern part of the Atlantic it occurs also at great depths.

The following is a list of the depths at which we have found a Globigerina-ooze:—

Atlantic Ocean.

fms.	fms.	fms.	fms.	fms.	fms.
1090	1900	2200	1350	1425	2275
1525	1950	1675	900	1650	2475
2250	2325	1675	2025	2300	2200
2225	1420	1240	2660	2300	2150
1945	2575	1000	2675	2400	2275
1975	2450	2500	2400	2400	2050
1150	2475	2275	1500	2075	1900
2300	2175	1850	1900	780	2025
2025					

Southern Ocean.

fms.	fms.	fms.	fms.	fms.	fms.
1900	1570	1375	1600	1800	2150

Pacific Ocean.

1974	1350	1675	2925	1915	1500
1100	1450	2000	2425	1600	1825
275	1700	1100	1940	2025	1775
400	1400	1850	2075		

3. *Radiolarian Ooze.*—Organisms with the siliceous skeletons abound in the surface-waters, and apparently also in the deepest waters, of all the oceans and seas we have visited.* The skeletons of these organisms are found in all, or almost all, the sea-bottoms. Even in those cases where at first sight they would seem to be quite absent, a more careful examination (by dissolving away a large quantity of carbonate of lime where this exists, and examining the sediment by careful washing in the case of clays, etc.) will usually reveal a Radiolarian skeleton, a Diatom frustule, or broken portions of these.

* They are, however, much more numerous in the Pacific than in the Atlantic, especially in the equatorial waters.

It is, however, only in some limited areas that these exuviæ rise into such prominence as to be characteristic of the deposit taking place. Such is the case in the Antarctic, where we have a Diatom-ooze, and in the Western and Middle Pacific, where we have the above deposit.

Our deepest sounding (4475 fathoms or 4575) was a Radiolarian ooze; with the exception of a little amorphous matter, manganese particles, a few yellow cherty-like particles, and some pumice pieces, this bottom was entirely composed of the exuviæ of organisms with siliceous skeletons—as Radiolaria, one or two Diatoms, and some organisms which seem to be undescribed (Challengerias), but which are numerous in the deeper waters of the Pacific.

A section of about three inches came up. The upper two were of a red color, due to the presence of much manganese; the lower one was of a pale straw-color, and contained relatively few manganese grains.

In our trip from the Sandwich Islands to the Society Islands we again met with Radiolarian ooze. Between 7° and 12° north of the equator we came on a patch represented by four soundings, some of these containing not a single *Globigerina;* then just on the equator, in two soundings, one at a depth of 2925 fathoms, we got a Globigerina-ooze containing a good many Radiolaria. Between 2° and 10° south we again had a patch of Radiolarian ooze represented by three soundings, and containing only a few pelagic Foraminifera or their broken parts. The occurrence of this patch of Globigerina-ooze in the position indicated, and the comparative or total absence of the Globigerina-shells in the deposits a little to the north and south of it, is sufficiently curious and significant. It will be well to note that, in the Globigerina-patch, manganese and other mineral particles are much less abundant than in the adjacent Radiolarian. Note also the presence of the south equatorial current and the dip of some isotherms over the Globigerina-patch. One or two soundings to the east of Japan might have been classed under this head; but in them the siliceous remains do not make up over one third of the sample in bulk. Generally it may be said that in the Western and Middle Pacific the siliceous remains of Radiolaria and Diatoms are abundant in the deposits, whereas in the South Pacific and Atlantic they are much less so, or absent in the bottoms.

The following are the depths of the soundings placed under the head of Radiolarian ooze:—

fms.	fms.	fms.	fms.
4575	2700	2250	2350
4475	2900	2600	2750
2750			

4. *Diatomaceous Ooze.*—South of the latitude of the Crozets, on our southern trip, we found Diatoms abundant, both in the surface waters and in the bottom.

About the Crozets, Kerguelen, M'Donald's Islands, and close to the ice-barrier, the frustules of these organisms were very abundant in the soundings, but were masked by much land-débris. Between the parallels of 53° and 63° S., i. e., between the north edge of the ice and the latitude of M'Donald's Islands, we got in three soundings a pale straw-colored deposit, composed principally of the frustules of Diatoms and their broken-down parts. In addition, they contained a good many Radiolarian remains, a few specimens of one small species of *Globigerina*, a few particles of mica, quartz, and granitic pebbles, also a little amorphous blue clayey matter. No manganese particles were noticed. The one of these soundings which is nearest to the ice contains much amorphous clayey matter and larger mineral particles than the other two. When dried this deposit is of a white color, and is very light.

The depths of the soundings referred to above are 1260, 1975, and 1950 fathoms.

5. *Red and Gray Clays.*—By far the most abundant oceanic deposits are the deep-sea clays. These are of a gray, red, or dark chocolate-color, and are found at depths greater than 2000 fathoms. The red and chocolate-colors of many of these clays are due to the presence of oxide of iron in the first and oxide of manganese in the latter instance. Most of them contain some carbonate of lime in the form of Globigerina shells; in one or two instances, however, I have not been able to find a single shell, nor has acid caused the least bubble of effervescence. The remains of siliceous organisms occur also in great numbers in the clays of some regions—so much so that, as I have stated, some of those soundings in the Northwest Pacific which have been classed as clays might have been called Radiolarian ooze. In most places, however, they are nearly or quite absent. These clays are not amorphous in the true sense of the word—not amorphous in the sense in which a chemical precipitate is amorphous. They all contain small white and other colored mineral particles in great abundance—exceedingly small particles, so as to be recognized only under the high powers of the microscope. They contain amorphous matter, it is true: but it is doubtful if this ever makes up so much as a half of any sample in bulk. They also contain larger mineral particles, as quartz, mica, pumice, scoria, peroxide of manganese, and other mineral particles. Quartz and mica particles appear to be present only in some localities, as the North Atlantic and elsewhere. Peroxide of manganese is perhaps always present in the form of grains or nodules, sparingly distributed in some

regions, in others making up nearly a half of the deposit or formation.

Pumice (the common feldspathic or the highly vesicular augitic variety) and scoria appear to be universally distributed over the bottom of the ocean, and to be abundant in most of the deep-sea clays and present in them all. In those clays farthest from continents and islands, sharks' teeth, ear-bones of whales, other bones of whales, and bones of turtles (?) are very frequently found, all these having usually a more or less thick coating of peroxide of manganese. The following are the depths at which we have found these red and gray clays:—

Atlantic.

fms.	fms.	fms.	fms.	fms.	fms.	fms.
2740	2575	3025	2475	2650	2875	2700
2950	2435	2800	2600	2500	2750	2350
2750	2385	2960	2850	2360	2750	2275
2800	2675	2850	2675	2575	2700	2550
3150	3000	2700	2800	2850	2750	2650
2720	2975	2600	2650			

Southern and Pacific Oceans.

fms.	fms.	fms.	fms.	fms.	fms.	fms.
2600	2275	2500	2900	2740	3000	2250
2600	2550	2425	2775	3125	2900	2335
2600	2650	3900	2050	2025	2610	2270
2900	2450	3600	2530	2850	2350	2400
2650	2325	2900	2900	2950	2325	2600
2325	2300	2300	2300	2875	2385	2550
2450	2475	2575	2350	2775	2450	2300
2440	2450	2800	2900	2225	2375	

6. *The Manganese in Deposits.*—The peroxide of manganese, in the form of minute grains, concretions, nodules, aggregations, or incrustations, occurs widely distributed in ocean-deposits. It has been met with most frequently in the deep-sea clays; indeed it seems to be present in all of them, sparingly in some localities, abundantly in others.

It is, however, not confined to these clays; it has been found in most of the other deposits and at all depths greater than 500 fathoms. In the Globigerina- and Radiolarian-ooze and in the clays it usually assumes the forms of minute grains, pellets and nodules. In those bottoms to which it gives a chocolate color, the higher powers of the microscope show small, round, red-brown grains of manganese, often with a dark spot in the center.

The nodules vary from little pellets to masses of a large size and of several pounds in weight. In some regions everything at the bottom, even the bottom itself, would appear to be overlaid by and impregnated with this substance. In the foregoing list, as at No. 318 and elsewhere, some of the nodules have

been described with a little detail. The varieties which are most commonly procured may be here mentioned:

(*a.*) Nodules of a black-brown color throughout, the manganese being laid down in concentric layers, which are evident from their enclosing lines of red clay.

(*b.*) Nodules having a nucleus of pumice which is surrounded by concentric layers, the original nucleus being often very deeply impregnated by spider-like ramifications of the manganese, or nearly the whole pumice may be replaced by manganese. When pieces of bone have formed the nucleus we have much the same state of things. The compact bone of the tympanics of cetaceans does not, however, appear to alter so rapidly as other bone; and hence it may be that we get ear-bones in such great numbers.

Sharks' teeth of all sizes (one was four inches across the base) are frequent, and are sometimes surrounded by concentric layers of nearly an inch in thickness. A siliceous sponge (*Farrea*) was found imbedded in two inches.

A mass of red clay may occupy the center of the nodule. The nucleus is occasionally a mottled yellow-and-green substance, with agate bands in some parts, and *Globigerina*, the carbonate of lime being replaced by silicate in these last. This nucleus can be cut with a knife, like new cheese, or it is hard and brittle, breaking with a conchoidal fracture.

Large flat aggregations occur which seem to have been formed on hardened flat portions of the bottom.

The Globigerina-shells and Radiolaria are at times covered by small specks of the manganese; and in the former these are deposited in the substance of the shell.

In several soundings and dredgings to the southwest of the Canaries we got very many large pieces of a branching Gorgonoid which were deeply coated and impregnated with manganese. This was in a depth of from 1100 to 1575 fathoms.

In 670 fathoms, off the Desertas, the dead shells, pieces of coral, Polyzoa, etc., were all coated with a thin film of the peroxide of manganese; and we have had indications of the same thing in still shallower water.

In some of the Radiolarian oozes, and in other deposits, we have found the manganese more abundant in the upper layers than in the lower, and *vice versâ*.

The following are the localities where we have met the manganese in greatest quantities:

Off the Canary Islands; Mid-Atlantic, between Canary and Virgin Islands; southwest of Australia; north and south of the Sandwich Islands; north of Tahiti; generally in the South Pacific in our course between Tahiti and Valparaiso.

Further observations may show that manganese abounds in those places where we have much of the débris of augitic lavas.

7. *Abyssal Rhizopods, Bathybius.*—The manganese nodules, sharks' teeth, etc., which we got in our deepest trawlings have very frequently small branching tubes, composed of clay and sandy particles, running over their surfaces. These belong to a Rhizopodal organism. The sarcode which fills these tubes contains many large brown pigment-cells, and small bioplasts are collected in clumps at distances along the length of the tube, or are scattered throughout it.

Tubes of a similar nature, but composed of pieces of *Globigerina*, Radiolaria, etc., would appear to be rather abundant on some of the oozes, and to run irregularly over the bottom.

In the clays we always get some arenaceous forms of Foraminifera when there has been a successful haul with the trawl. Their shells are made up of pieces of manganese, clay, and small mineral particles, and they contain the same kind of sarcodic substance as the tubes above referred to.

An attached calcareous form (c. f. *Carpenteria*) has been found in rather deep water, and Biloculinas, Nodosarias, Triloculinas, and other forms have been frequently procured alive. These last have orange-colored pigment-cells, in which respect they resemble surface Rhizopods. A living specimen of *Orbulina* or *Globigerina* undoubtedly from the bottom has not yet been met with.

In the early part of the cruise many attempts were made by all of the naturalists to detect the presence of free protoplasm in or on the bottoms from our soundings and dredgings, but with no definite result. It was undoubted, however, that some specimens of the sea-bottom preserved in spirit assumed a very mobile or jelly-like aspect, and also that flocculent matter was often present.

Mr. Buchanan determined that the flocculent matter was simply the amorphous sulphate of lime precipitated by spirit from the sea-water.* Subsequently a number of experiments were made upon the behavior of this amorphous precipitate when precipitated with different quantities of spirit and when treated with coloring solutions. The precipitate was also examined alone and mixed up with some of the ooze. The ooze was examined at the same time, and in the same manner, but without having been treated with spirit. The results were briefly these:

(*a.*) When sea-water is treated with twice its volume of spirit or less, nearly the whole of the amorphous precipitate assumes the crystalline form in a short time.

* See a paragraph from Mr. Buchanan's report on the following page.

(*b.*) When treated with a great excess of spirit the precipitate remains amorphous, and assumes a gelatinous aspect.

(*c.*) This gelatinous-like sulphate of lime colors with the carmine and iodine solutions, and when mixed with the ooze has, under the microscope, the appearances so minutely described by Häckel.

(*d.*) The ooze washed with distilled water, or taken just as it comes up, and treated in the same manner with coloring-solution, does not show these appearances. The jelly-like aspect and the matter colored with carmine can always be removed from the spirit-preserved specimens of the ooze by treating with distilled water.

(*e.*) In all cases the jelly-like or mobile aspect of the oozes is found to be due to the presence of the flocculent precipitate from the sea-water associated with the ooze.

(*f.*) No free albuminous matter could be detected.

When it is remembered that the original describers worked with spirit-preserved specimens of the bottom, the inference seems fair that *Bathybius* and the amorphous sulphate of lime are identical, and that in placing it among living things, the describers have committed an error.*

* Mr. J. Y. Buchanan, chemist and physicist to the Expedition, makes the following remarks on *Bathybius* in his Report, p. 605 of the Proc. Roy. Soc., vol. xxiv. Read March 16. In connection with carbonic acid I may mention that I have frequently tested waters, and especially bottom-waters, for organic matter. None of the methods in use for determining this substance in drinking-water giving satisfaction when applied to sea-water, I had to content myself with endeavoring to detect its presence. If the jelly-like organism which had been seen by some eminent naturalists in specimens of ocean-bottom and called *Bathybius* really formed, as was believed, an all-pervading organic covering of the sea-bottom, it could hardly fail to show itself when the bottom-water was evaporated to dryness and the residue heated. In the numerous samples of bottom-water which I have so examined, there never was sufficient organic matter to give more than a just perceptible grayish tinge to the residue, without any other signs of carbonization or burning. Meantime my colleague, Mr. Murray, who had been working according to the directions given by the discoverers of *Bathybius*, had actually observed a substance like "coagulated mucus," which answered in every particular, except the want of motion, to the description of the organism; and he found it in such quantity that, if it were really of the supposed organic nature, it must necessarily render the bottom-water so rich in organic matter that its presence would be abundantly evident when the water was treated as above described. There remained, then, but one conclusion, namely, that the body which Mr. Murray had observed was not an organic body at all; and on examining it and its mode of preparation I determined it to be sulphate of lime, which had been eliminated from the sea-water always present in the mud, as an amorphous precipitate, on the addition of spirit of wine. The substance when analyzed consisted of sulphuric acid and lime; and when dissolved in water and the solution allowed to evaporate, it crystallized in the well-known form of gypsum, the crystals being all alike, and there being no amorphous matter among them.

These observations were made chiefly on the voyage from Hong Kong to Yokohama in the first quarter of the year 1875; and it subsequently occurred to me that an approximate determination of the organic substance in sea-water might be effected in the following way: Supposing the amount of carbonic acid in the water to be known, let a little permanganate of potash be added to a sample of it,

8. *Origin of Deep-Sea Clays. Relative rate of Deposition of Deposits. Conclusion.*—The very wide distribution of pumice, vesicular lava, or light scoriæ has been already alluded to. Some of the bottoms which have been classed under the head of clays, as 2900 fathoms south of Tongatabu, are largely made up of pumice in a fine state of division. Pumice or vesicular lavas have, in short, been found in all the kinds of deposits, most abundantly in the vicinity of volcanic islands and in the deep-sea clays. It appears to be universally present, and its disintegration is most probably the chief source of the clayey matter found in oceanic deposits. North of the Sandwich Islands we for several days got small pieces of pumice floating on the surface, most of the pieces being covered with a fungoid growth. In this connection it may be well to remember that Mr. Bates states somewhere that he found pumice rather common, floating on the surface of the Amazons, over a thousand miles from the nearest volcanic region. Many instances are given by Sir Charles Lyell of volcanic ashes having been transported to great distances by the wind.

At Honolulu Mr. Green informed me that *Pele's hair* had been picked up in his garden there after an irruption of Kilauea in Hawaii, a distance of about 180 miles from the crater. If there be an ash after the carbonate of lime is removed by carbonic acid or other agent, this will be another source of the clay.

Mr. Buchanan has determined in the clays the presence of copper, cobalt, and nickel, in addition to iron and manganese. Remembering this, one is tempted to suggest the presence of meteoric or cosmic dust in these deposits.

When we have had a good haul from a red-clay bottom, when the bag comes up full of nodules, tympanic bones, and sharks' teeth, we cannot resist the idea that we are dealing with things of a vast antiquity, and that we have evidences of a very slowly accumulating deposit. When there has been no reason to suppose that the trawl has sunk more than one or two inches in the clay, we have had in the bag over a hundred sharks' teeth and between thirty and forty ear-bones of cetaceans; some of these have been imbedded in over an inch of the manganese, arranged in concentric layers, while others have had just a trace of manganese on them, or none at all. We have every reason to suppose that the aggregation of the manganese around these relics is a very slow process, and that

and let the carbonic acid be determined in the usual way by boiling the solution. If the water contained any easily oxidizable carbon compound, we should obtain more carbonic acid in the second than in the first determination, and the difference would correspond approximately to the amount of organic carbon present. In several waters which I have treated according to this principle, I have found from two to five milligrams of carbon per liter.

consequently the occurrence of these deeply imbedded and recent teeth and tympanics in the same surface-layers argues strongly in favor of an exceedingly slow rate of deposition. These vertebrate remains are most abundant where the manganese abounds, but occur also in the red and gray clays, especially in those the farthest from the land, and where we may suppose the rate of deposition to be reduced to a minimum.

In the Globigerina, Radiolarian, and Diatom oozes we have found during the whole cruise only one or two sharks' teeth and perhaps one tympanic bone. In shore-deposits they were even more rare. These facts, taken with others that will at once suggest themselves, go to show, as might be expected, that the shore-deposits accumulate faster than the organic oozes, and these last faster than the deep-sea clay. The organisms in our Radiolarian ooze appear to resemble very closely, and in their relative proportions, those described from the Barbadoes earth. Those described from the Oran deposit in Algeria are very like those in the blue muds taken along the course of the Japan stream. The Globigerina-oozes which we get in shallow water resemble the chalk much more than those in deeper water, say over 1000 fathoms. It is possible that deposits similar to those taking place in deep water, far away from the great continental anticlines, may never have been elevated into dry land.

In conclusion, large quantities of the various bottoms have been stored with a view to future work, and a large amount of material bearing on the subjects treated of in this Preliminary Report have been accumulated. When these come to be carefully examined and compared, with the aid of appliances and conveniences not to be had on board ship, many of the statements herein made may require to be altered and amended, and other facts and relations, more curious and interesting than any hinted at, may be revealed.

ART. XXXIII.—*On Gmelinite from Nova Scotia;* by A. B. HOWE. (Contributions from the Sheffield Laboratory. No. XLII.)

WHILE in Nova Scotia, during the summer of 1875, our party found this comparatively rare mineral in considerable quantities, but of two very distinct and different habits. In order to see if this difference of habit could be accounted for by any difference in chemical constitution, the following analyses were made.

The first variety is from a locality called Two Islands, and presents the general appearance very closely of that from Cape Blomidon, which is nearly opposite to this locality. The rhombohedral planes, *R* and −1, are very nearly equally developed, and the lateral planes *i* are very distinct and are striated horizontally. The basal plane *O* is developed to a varying extent in different crystals, but is plainly discernible on all, unless the crystal is imbedded in the matrix or in another crystal so as to conceal it. The plane 1-2 is occasionally seen and usually has a slightly hollow or concave form, and sometimes is represented by simply a slight groove or line along the edge formed by the intersection of the planes *R* and −1. The color is a pale flesh-red or a cream-white.

In the variety from Five Islands, a locality distant about eight miles from Two Islands, the general appearance is very different, resembling very much that of acadialite. The planes are nearly the same as in the Two Islands variety, but their relative development is very different. The basal plane *O* is wholly wanting, and the plane −1 is extremely minute in most cases, being hardly discernible on some crystals. The lateral planes *i* are still present, or rather a series of them, each individual being small and brilliant, having lost their horizontal striations. One of the most characteristic planes is that truncating the edge between *R* and −1. This plane 1-2, is distinctly striated parallel to its intersection with the plane *R*, and is always present, even on the smallest crystals, although in some cases it is very much broken and deeply striated. The whole crystal presents the general form of a nearly perfect rhombohedron, some of the faces being nearly perfect, while others are made up of a number of minute crystals, forming an uneven surface. The color is much deeper and brighter than that of the other varieties. On some of the larger crystals there is evidence of twinning, but these have not yet been examined to ascertain if they are true twins.

In order to compare the composition of the Nova Scotia mineral with that from Bergen Hill, an analysis of the latter was also made, but on account of the lack of sufficient quantity it was not made in duplicate. The habit of this variety was intermediate between the other two. The rhombohedral planes *R* and −1 are unequally developed though to a less extent than the Five Islands variety, and the basal plane *O* is wanting. The prismatic plane *i*-2 was not observed on any of the crystals, although some of the Bergen Hill specimens showed an apparent tendency to put on this plane.

The following angles were measured directly with an application goniometer, and agree pretty closely with those given in Dana's Mineralogy:

$R \wedge R = 112° 27'$, $O \wedge R = O \wedge -1 = 140° 7'$, $R \wedge 1\text{-}2 = -\wedge 1\text{-}2 = 161° 10'$,* $R \wedge -1$ pyr. $= 142° 20'$, $R \wedge -1$ bas. $= 79° 27'$.

The following are the results of the three analyses:

Two Islands variety.

			Mean.
Silica	51·36	51·35	51·36
Alumina	17·85	17·77	17·81
Ferric oxide	·15	·16	·15
Lime	5·66	5·70	5·68
Soda	3·90	3·94	3·92
Potash	·24	·21	·23
Water	20·96	20·97	20·96
	100·12	100·10	100·11

Bergen Hill variety.

Silica	48·67
Alumina	18·72
Ferric oxide	·10
Lime	2·60
Soda	9.14
Potash	trace
Water	21·35
	100·58

This analysis is inserted between those of the Two Islands and the Five Islands varieties because it is intermediate between them.

Five Islands variety.

			Mean.
Silica	50·47	50·44	50·45
Alumina	18·26	18·29	18·27
Ferric oxide	·16	·17	·17
Lime	1·13	1·10	1·12
Soda	9·75	9·83	9·79
Potash	·19	·21	·20
Water	20·72	20·71	20·71
	100·68	100·75	100·71

These three analyses give the following atomic ratios respectively:

	Na(K) : Ca,	Ca : Al,	R : Al : Si, (2 Na=R)	Si : H.
Two Islands	1·2 : 1	1 : 1·7	·97 : 1 : 4·9	1 : 2.7
Bergen Hill	6·1 : 1	1 : 4	1 : 1 : 4·5	1 : 2·9
Five Islands	15·4 : 1	1 : 8·8	1 : 1 : 4·7	1 : 2·8

The ratios which Rammelsberg gives as the theoretical are R : Al : Si = 1 : 1 : 4 and Si : H = 1 : 3.† On comparing these

* Five Islands. The others from Two Islands. Calculated from measurement of 1-2 ∧ 1-2.

† Rammelsberg's Handbuch der Mineralogie, p. 626.

analyses with those given by Rammelsberg, it will be seen that, like the majority of those, they give an excess of silica over that required by the ration 1 : 1 : 4. This excess is very marked in the Nova Scotia varieties, but in these it may be partly accounted for by a slight decomposition which may have taken place. The Bergen Hill crystals, however, were very evidently sound and undecomposed, and the excess in this case can not be accounted for in that way.

Both the Nova Scotia varieties had apparently undergone a slight alteration. The crystals were somewhat porous and hollow, and thus would be exposed to easy decomposition; or this structure may have been the result of alteration. Thin sections examined under the microscope with polarized light afforded no evidence of free quartz. If the bases had been removed during decomposition, they had been removed in the proportion in which they existed in the mineral originally, for the ratio of R : Al is closely alike in all the varieties. The excess of silica may have been left in such a form by the decomposition that it would not show itself under the polarizer. The crystals from Bergen Hill however were perfectly sound and unaltered. They gave a very perfect hexagonal and also a basal cleavage, as did the other varieties though not so easily as this. The basal cleavage is not so readily obtained as the prismatic. On treating the finely ground mineral with hydrochloric acid, decomposition with separation of finely-divided silica took place, but there were no traces of gelatinization.

Several experiments were made on the loss of water by heating, but with no satisfactory results. The mineral, even when in coarse fragments, loses weight steadily in dried air at the ordinary temperature. At the end of eleven days over oil of vitriol it had lost about 4 per cent and was still losing at a nearly constant rate. After two days drying at a temperature of 100° C., a constant weight was reached which gave a loss of 7·65 per cent. A constant weight was obtained at a temperature of 115°–120° C., giving 8·82 per cent loss. Another was also found at 160°–180° corresponding to a loss of 17·02 per cent. Still others were found at 200°–210° and at 250° equal to 19·42 and 20·40 per cent respectively. At every temperature mentioned the loss was rather rapid at first, gradually becoming slower and slower till a constant weight was obtained. Apparently the mineral possesses the property of giving a constant weight at any temperature, which may account for the very various results which other experimenters have obtained. The water is driven off completely at a red heat, and the powder becomes sintered together into a mass but without absolute fusion.

It is interesting to notice the fact that the habit of crystalli-

zation corresponds to the difference in chemical composition, at least so far as these three varieties are concerned. In the specimens from Five Islands, in which the protoxide bases are almost wholly made up of soda, the crystal is decidedly rhombohedral in character; the plane -1 is exceedingly minute and the basal plane O is wholly wanting. In the Bergen Hill crystals which were used in the analyses, and are intermediate in composition between the other two, the crystals have not so decidedly a rhombohedral appearance, although R and -1 are very unequally developed. In the crystals from Two Islands, where the lime nearly equals the soda, the planes R and -1 are very nearly equal in size and the basal plane O has made its appearance. The question what change in the crystalline habit a further increase of lime would produce is an interesting one, but must remain unanswered till specimens containing more lime are analyzed and described.

ART. XXXIV.—*On the occurrence of Durangite in the tin-bearing region of Durango, Mexico;* by HENRY G. HANKS.

UP to the present time no account of the mode of occurrence of durangite has been published. Although I have made persistent effort to learn some facts bearing on this subject during the last seven years, since the first description appeared in this Journal, I have never been able to obtain anything reliable until now.

It has been stated in a general way, that this rare mineral was found with stream tin in Durango, Mexico; but as the hardness of durangite is only 5, it has heretofore been impossible to account for the perfect state of the crystals as they reach us.

I am able at last to throw some light on this subject, deriving my information from Mr. J. F. Boyd, of Durango, and Mr. Ayres, of Coneto, Mexico, both of whom have lately visited San Francisco. According to these gentlemen, durangite has been found only in the "Barranca" tin mine and never in the beds of streams. The tin fields in which this mine is located lie about eighteen miles northwestwardly from Coneto, State of Durango, Mexico, and about ninety miles in the same direction from the city of Durango. This would locate them nearly in lat. 23° 30′ north, long. 104° 30′ west. The mines are embraced in a circle which could be swept by a radius of thirteen miles. The whole area is cut up by arroyos, varying in width from ten to one hundred and fifty feet, and of unequal depth. In the beds of these arroyos, through all of which water runs during a por-

tion of the year, and in a few of them during the whole of the year, stream tin is found underlying sand and gravel. The tin ore is sometimes found in bars or flats, sometimes mixed with the surface earth; but generally at a depth of six to ten feet beds of tin pebbles are found. In exceptional cases deposits two feet in thickness have been uncovered, presenting the appearance of a gravel pavement.

Crossing the arroyos, veins of tin occur in threads and seams, from a few inches up to several feet in thickness. All the larger veins have smaller and richer ones intersecting them. One well-known vein is from forty to sixty inches thick, yielding from twenty to twenty-six per cent of tin stone, while the smaller veins crossing it produce as high as sixty-eight per cent with the same treatment.

The tin ore is invariably found in what Mr. Boyd describes as a "whitish cement" which softens readily in water, allowing the cassiterite to fall to the bottom of the washing troughs. Mr. Boyd thinks the character of this formation controls the purity of the tin. When it has a yellowish shade he expects to find the tin contaminated with arsenic, iron, and bismuth. If light gray or white, he notices that the vegetation is stunted, but the character of the tin produced is much improved. Ores yielding from eighteen to thirty per cent are very abundant, but do not pay to smelt without concentration. Associated with the tin ores are found fluor spar, calcite, chalcedony, and topaz.

The altitude of these tin fields is from nine thousand to ten thousand feet. All the hills are beautifully overgrown with grass and shrubbery. The mines occur in a crust of a lighter color than that of the general country. This formation is from seven hundred to twelve hundred feet in thickness overlying the gold, silver and lead-producing formation. Sometimes a high hill or mountain top is seen to be capped with the tin formation.

Over the entire tin fields prospecting holes have been sunk, the bed rock being reached at a depth varying from three to ten feet. These shafts have never failed to develop stream tin in greater or less quantities. During the wet season, commencing in the middle of June, great quantities of rain fall. Advantage is taken of the abundance of water to sluice out the stream tin, to be smelted during the dry season. The smelting is done in a rude way in furnaces built of adobes, yet it is stated that metallic tin can be produced at a cost of two cents per pound. The tin ore is found loose in the veins in irregular rounded masses, from minute sand-like particles, to pieces the size of a man's head. A curious form resembling small cylinders or stalactites is not uncommon.

Mr. Boyd estimates the number of veins known at six hundred, and the number of streams or arroyos yielding stream tin

at three hundred. This gentleman thinks that the tin ore is still forming. He assures me that work having been suspended on a mine in 1864, a portion of the vein was left standing. In 1870 he visited it again and found that new films or layers of cassiterite had formed, and in some places noticed that peculiar variety known as toad's-eye tin which he believes had formed during his absence.

These mines were discovered and worked on a small scale by the Spaniards from 1790 to 1824. From 1835 to 1846 they have been worked by Don Manuel Gracia, a native Mexican of Spanish descent, who amassed a fortune by extracting the tin and carrying it on mules to the city of Mexico, 590 miles distant.

Barranca is the name of a group of small veins rather than that of a single one. The vein in which the durangite is found is from four to six inches in thickness. It rises from a deep cañon, is nearly vertical, dipping but slightly. The fissure is filled with loose vein matter containing cassiterite in cylindrical pieces, quite small. Crystals of durangite occur singly with cassiterite in the white pulverulent matter before described. Beautiful crystals of a larger size and of a light orange color are sometimes met with attached to the walls of the vein. I have a few of these in my collection; they are quite different from those found in the vein matter. It was this variety which was first described by Prof. Brush.

The vein matter is described as being highly charged with arsenic. When thrown into the furnace, so abundant are the arsenical fumes evolved that the workmen cannot endure them, and a preliminary washing process is resorted to, by which a large proportion of the arsenical matter is removed. Sometimes in washing the vein matter, crystals of durangite are found, as are also those beautiful topaz crystals which have found their way to the cabinets of mineralogists in all parts of the world.

I understand Mr. Boyd to say that the crystals of durangite are only occasionally met with. The largest crystal known is now in my possession. It weighs 3·022 grams. Its greatest length is 19 millimeters and its extreme thickness 11 millimeters. The edges are sharp and all the angles well defined and perfect. There are some imperfections on some of the faces. It is of a beautiful orange-red color, resembling bichromate of potash.

The crystals found in the vein matter are usually small, and of a darker color. On weighing one hundred of them to ascertain the average, I found their combined weight to be only 7·750 grams.

San Francisco, 619 Montgomery St.

ART. XXXV.—*On the occurrence of Grahamite in the Huasteca, Mexico, and Notice of the Geology of that Region;* by JAMES P. KIMBALL, Lehigh University, Bethlehem, Pa.

THE descriptions of the albertite deposit of Hillsborough, New Brunswick, by Professor C. H. Hitchcock,* and of the grahamite deposit of the Ritchie Mine in West Virginia by Mr. W. M. Fontaine,† as well as by Mr. Henry Wurz,‡ show these deposits to widely differ from any known, or even possible, occurrence of mineral coal, from the nature of which albertite and grahamite have been shown by Wetherill, Wurz, and others, likewise to differ essentially. Both varieties occur in the state of Vera Cruz, Mexico, under such circumstances as to exhibit well the nature and proximate origin of such deposits.

A closer comparison of the two varieties, by means of a more extensive series of analyses than has yet been published, is required to fix the exact relationship between them. As distinguished by physical properties, they seem to pass into each other by insensible gradations, especially in the Ritchie deposit, and in such of the Mexican deposits as I have seen. Such analyses as are at hand, of specimens from one and the same deposit, indicate inconstant ratios in each variety—evidently depending on the degree of oxidation. This variableness shows that neither variety is a true mineral species, any more than other native hydrocarbon compounds, like petroleum, asphaltum, or mineral coals. The following observations serve to confirm the received theory of the nature and origin of albertite and grahamite, and to demonstrate that these bodies are essentially mineralized or fossilized asphaltums, derived from asphaltic petroleum, pittasphalt or maltha, by the loss of hydrogen and the addition of oxygen. In the degree of this alteration albertite seems to occupy a place between asphaltum and grahamite—the two varieties, however, constituting a single mineral type. The degree of oxidation of such compounds does not always correspond to the amount of retained or fixed oxygen—a large proportion of the increment of oxygen forming volatile compounds along with carbon and hydrogen, especially in the more advanced changes which result in their conversion to such anthracitic bodies, low in oxygen, as are often found in cavities of the rock in the older formations.

Numerous springs of asphaltic maltha, forming in places superficial deposits of solid asphaltum, occur on the eastern slope of the Cordilleras of Mexico, or rather, in the littoral zone

* This Journal, xxxix, 1865, 26–7.
† Ibid., vi, III, 1873, 409. ‡ Ibid., xlii, II, 1866, 420.

toward their base. A small lake fed by a spring of bitumen is reported to occur as far north as Galveston Bay in Texas within the Tertiary area.* More or less extensive sources of the same substance are common throughout the large area watered by the numerous streams discharging into the Tampico and Tuspan rivers, at whose mouths are the gulf ports of Tampico and Tuspan. A considerable quantity of chapapote, as it is called, is brought down by these streams, washed out to sea, and finally left upon the beach by the action of the waves. After such a thorough exposure to the elements, it loses its pitchy consistency, and becomes brittle and lustrous like jet. It has then a conchoidal fracture. In this condition it is sometimes gathered, and, though not extensively known, is highly esteemed as an article of export

The northwestern portion of the state of Vera Cruz is known as the Huasteca, which may be described as the area south of the Panuco River, embracing the territory to the north of the plateau of Anahuac, watered by the three forks of the principal affluent of the Panuco—the Rio San Juan de Mexico—namely, the Capadero, the Amajaque and the Moctezuma. This section has received no attention from scientific travelers. In 1825, Burkhart, traveling from Tampico to Real del Monte, via Tantoyuca, passed along the upper Capadero. This river he mistook, however, under the name of the Rio Garzes, and supposed it to have an easterly, instead of a northerly, course, and to empty into the Laguna de Tamiagua. Saussure's map of the plateau of Anahuac represents this portion of Mexico with some approach to its geography, if not to its topography.†

Last April I made the journey from Tampico to Tempoal on the Capadero, crossing the Topila at Tanseme, and returned to the same port by way of Trinidad and Panuco. The topographical features of the country, which thus came under my observation, are not unlike what I have described to be the character of the eastern slope of the Cordilleras farther north as observed in Chihuahua.‡

The same succession of longitudinal valleys separated by parallel ridges is here seen, together with the same gradual acclivity toward the summit of the Sierra Madre, which in this latitude is about Zacatecas. The valleys, though broad, are, unlike the champlain valleys of Chihuahua, comparatively rugged, owing to the uneven erosion of the sedimentary rocks, which is caused by intrusions of trachyte. Their configuration is largely due to the successive changes of the beds of streams,

* Taylor, Statistics of Coal, p. 498.
† Coup d'œil sur l'hydrologie du Mexique, Geneva, 1862.
‡ This Journal, xlviii, 1869, p. 385.

caused by the gradual elevation, or periodic oscillations of level, of the Cordilleras during the Tertiary period and afterwards, and which phenomena, as I have elsewhere noted, are likewise strongly marked in northern Mexico.*

The area over which my route lay, is occupied by argillaceous sandstone, calcareous in places, whose foldings seem, generally speaking, to correspond with the present configuration of the surface, the whole of which, however, has been subjected to a very powerful erosion. One of the most remarkable evidences, both of the gradual character of the elevation of the Cordilleras in the lower latitudes, and of the fluvial character of their erosion, is to be seen in a widespread alluvium, composed of coarse gravel and heavy rolling stone in the valley of the Capadero, observed many miles away from the present channel of the river, wherever its heavy covering of fine silt-like alluvium has been washed away. Through these two superficial deposits successively the river has cut its present channel deep into a formation of soft shale beneath, locally known as *t-petate*, which overspreads the whole valley of the Capadero.

The shale is highly fossiliferous in places. Imperfectly indurated and weathering excessively, it causes the fossils to crumble. They include *Cardium*, *Arca*, *Ostrea*, *Corbula*, *Pecten*, *Caryatis*, *Serpula*, and a discoid, coiled and chambered rhizopod. With the exception of the last, all are too imperfectly preserved to admit of specific determination. Common to both the Cretaceous and Tertiary as these genera are, such specimens as I was able to extract fail to distinguish between these two periods. In a private report, written without access to my collection, the shales were referred to the Cretaceous upon the grounds of the apparent facies of these specimens. They prove however, upon examination, to be wanting in characteristic types, and too uncertain of specific identification to rest any conclusion of the kind upon them, especially as the stratigraphical relations of the shales themselves indicate, as I shall presently show, an unbroken and immediate sequence with alluvial Quaternary deposits. Arguing from the latter circumstance, it will be seen that they are more logically referred to the Tertiary. These shales are important as the seat of the grahamite deposits in the vicinity of Tempoal, and probably throughout the much larger region of the Huasteca, including, at least, the middle portion of the Capadero basin, or so much of it as lies between the Huejutla Mountains on the west and the Alacranes hills on the east. The region thus defined corresponds to the so-called "Coal-field of the Huasteca," the coal, however, as I judge from

* This Journal, xlviii, 1869, p. 381.

such specimens as I have seen, really being grahamite and other less thoroughly altered asphalts.*

Judging from a number of specimens of these outcrops from farther up the Capadero than the district visited by me, as well as from such facts as I could gather by inquiry, it seems most probable that the shales of Tempoal and of the Cristo Mine, which came under my observation at these and other points in the banks of the Capadero, extend, at least, some 60 miles farther up the river, as far as Chalma, so as to include the so-called coal deposits at the base of the Cochiscuatitlan hills mentioned by Antonio del Castillo, viz., Purisima, Providencia and Virginia. A specimen of grahamite, now in my possession, from Huautla, 50 to 60 miles still farther up the river, suggests a still greater extension of the same shales, found to be the seat of grahamite at Tempoal and elsewhere.

Except in the banks of the river, and the beds of branching arroyos, the grahamite-bearing shales nowhere come to the surface in the Capadero basin, within the range of my observation, although not far below the level of the valley-plain, or lower terrace of the river. Together with grahamite, they are reported, and may be readily believed, to outcrop in the Huejutla Mountains, as at the Venados, where a deposit of the former was described by the messenger sent thither for specimens, to be upward of two feet in thickness.

The shales are immediately covered by the above mentioned deposit of coarse rounded rubble, generally more or less cemented by selenite so as to form a conglomerate from 3 to 6 feet thick, and containing shells of *Paludina*. This is immediately overlaid by the heavy deposit of fine alluvium, the least thickness of which, as seen in the river banks, is some 60 feet. It overspreads the whole valley in the vicinity of Tempoal, as well as of the Aguacates, some 12 miles farther up the river.

In the vicinity of Tempoal, where alone my examinations have been special, the top of the shales is generally brought by undulations above low water mark—that is, above the level of the river in the dry season. Near the village, it rises some 30 feet above this level; at the Parajes, two miles below, some 25 feet; at the Aguacates, 12 miles above, some 60 feet; while at the Cristo Mine, it is near the water's edge, though rising directly on either side. We have as yet no data bearing on the thickness of the shale, as its edges are everywhere concealed—if not by overlying alluviums—by a detritus resulting from its own weathering, as it slacks at once on exposure to the air.

* Some attention of late, in the City of Mexico and elsewhere, has been turned to this region upon the strength of rather venturesome computations of the extent and value of the alleged coal deposits, based upon unexplored outcrops of what is assumed to be beds of bituminous coal. (*Compania Explotadora de Criaderos de Carbon de Piedra.* Mexico, 1876. A report by Antonio del Castillo.)

At Tempoal, at the Cristo Mine, and at the Aguacates—three out of five points where I have observed exposures of the shales in the banks of the Capadero, grahamite is found in greater or less quantity. Like many similar Tertiary sediments, the shales are in places quite gypsiferous.

Remnants of these Tertiary shales are to be seen in the banks of the Panuco at Puebla Vieja, near the mouth of that river. The same formation seems to answer to Burkhart's description of the formation occupying the Garzes, (Capadero) valley as high up as Chapula, and even still higher, as far as a little south of Pinolco, with occasional protrusions of the lower sandstone series—including beds of limestone, as between Huautla and Tlacolula, and again, south of Zagualtipan.*

According to this traveler, the clay shale of the valley about Chapula apparently overlies unconformably the limestone, which he believed to be the upper member of the sandstone series, forming the heights all the way from the coast, except where covered by trachyte. The mesa tops of the mountains just west of Chapula are of the latter volcanic rock, which likewise seems to form the summits along the whole range to the north. Approaching the volcanic plateau of Anahuac, the whole body of sedimentary rocks—together with overlying trachyte, was observed by Burkhart to decline to the south and to pass beneath the diorite and basalt of the table-land, which was geognostically mapped by Gerolt and Berghes in 1827.†

Mention is made by Sr. Castillo of the discovery of an "hexagonal" sigillarid as well as nummulitic forms in the so-called coal-bearing rocks of the Huasteca. The sandstone series, in whose depressions the Tertiary grahamite shales have been preserved from a sweeping denudation, has furnished a few fossils at Tampico, where it has been quarried. I succeeded, however, in finding none but fragmentary gasteropods, though perfect specimens of the same are said to be preserved in private collections there, which it has not been my privilege to see. So doubtful is the existence of true coal in the Huasteca, that the alleged discovery of palæozoic fossils, as claimed in Mexico by way of confirmatory evidence, as I infer, of the carboniferous age of the sandstone series—requires the support of other facts. It is proper to remark that in the interior of the country, the rock surfaces are absolutely unbroken, while covered with a tropical forest; hence the present impracticability of a successful search for fossils in this part of Mexico.

Burkhart also identified in the banks of the "Rio Grande" (Amajaque) the same formation of clay shale observed by him

* Aufenthalt und Reisen in Mexico in den Jahren 1825 bis 1834. Stuttgart, 1836. I, p. 53.

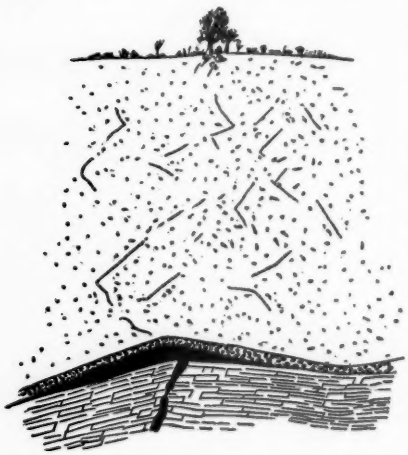
† Carta Geognostica de los principales Distritos Minerales del Estado de Mexico, 1827.

between Chapula and Pinolco in the Capadero basin, and thence inferred the geological identity of these neighboring basins.

I now proceed to describe the deposit of grahamite known as the Cristo mine.*

The original outcrop of the deposit appeared at the base of the west bank of the Capadero, on the Cristo Ranch, near the edge of the river at low water, and below the surface of the water during the rainy season. It appears to have been long observed, and to have been regarded by some persons as a deposit of bituminous coal, and by others as chapapote, but to have remained unexplored—perhaps through some discovery of its ill adaptation to the ordinary purposes of either fuels or asphalts. In 1873, the deposit was denounced as a coal-mining property.

The deposit consists of two continuous parts, the one occupying a nearly vertical fissure traversing the fossiliferous shales, and the other part conformably overlying these shales, which are slightly inclined. We have here the phenomena, first, of a deep-seated fissure transverse to the bedding of the formation, and filled out with grahamite; and, second, a nearly horizontal, and originally superficial, deposit of the same material overspreading the shale formation for a limited distance from the fissure. The latter occurrence is an overflow from the fissure, and, as it lies between the two formations, is to be referred to a period subsequent to the deposition of the shales, and before the conglomerate was spread upon them in the form of pebbly detritus. It thus happened when the shales formed the surface at this point, just as asphaltum is now commonly formed upon the surface, as a residuum from the evaporation and oxidation of liquid or pasty malthas, issuing from sluggish springs, or oozing from more extended sources, as from a certain stratum or rift in the rocks. Such phenomena, referable to the sandstone below, are to be seen beyond the boundaries of the shale formation in the neighborhood of the Cristo mine, and indeed are quite



* J. P. Kimball on a deposit of grahamite known as the Cristo Coal mine, with plate. 24 pp. 1876.

common in the surrounding portions of eastern Mexico, as already observed.

That portion of the overflow which originally appeared at the base of the river bank, has now been worked out, 210 tons having been quarried and shipped. So far as can now be ascertained, the overflow was altogether west of the fissure, which has a width, as far as developed, of 34 inches. The vein occupying the fissure has a columnar structure transverse to its sides, and shrinkage partings, or joints, parallel to its sides. It has thus far proved remarkably homogeneous in structure, and free from admixture of rock or clay. Its dip is 64° to the W. Near the point where it passes out of sight under the river bed, it is joined, at an acute angle, by a narrower and tapering vein of which the maximum width is 9 inches. According to those who have had charge of operations at the Cristo mine, the deposit, including both vein and overflow, was excavated within a dam to a depth of ten feet, and, at the same place, measured fifteen feet across. The vein proved of the same width as observed by me nearer the bank—that is, thirty-four inches. This point, now under water, was stated to be 120 feet from the base of the latter. Another small branch is partially seen on the opposite side.

The shape of the overflow is indicated as near as is now practicable, by the excavation outside of the bank and by the work underground. The latter consists of a timbered shaft, 72 feet deep, sunk from the top of the river bank or terrace, 196 feet from the edge. From the bottom two levels have been run out at right angles, one 19½ feet long toward the river (east), and the other 27½ feet long toward the north. These workings are in that portion of the deposit which for convenience I call the overflow. Its greatest thickness is developed in the east level, at the end of which it measures 6½ feet and dips 19½° S. W. At the end of the north level it has a thickness of but 15 inches, and a dip of 20° to the northeast. In the shaft the thickness of the deposit falls from 34 inches at the southeast corner, to 15½ inches at the opposite N. W. corner, to 20 inches at the S. E. corner, and to 15 inches at the N. E. corner. It therefore appears that the overflow of the vein has a limited spread underground, the same as it proved outside the bank at the water's edge. Its thickest portion is in the direction of the river, and continuous, I think, with the thickest part of the original outcrop; that is, the portion nearest the fissure, which was undoubtedly its source, and from which it sloped with the configuration of the surface at the time, and thinned away toward its edges. The fissure occupies the axis of a gentle anticlinal with a dip of 14° W. on the W. side, and of 4° E. on the opposite side. As the overflow conforms to the steeper dip,

it appears that the fissure must have been made at the time of the elevation of the shales, and soon afterwards filled with asphaltum, which continued to form after it had been filled. That no great period was required for this operation, is shown by the fact that the overlying conglomerate also conforms to the stratification of the shales as well as to the outline of the overflow of the grahamite, locally intervening.

The occurrence of such a fissure in shales so imperfectly hardened, and so easily weathered, affords another proof that the filling of the fissure immediately followed its formation, that is, after the emergence of the shales and before the deposition of the overlying alluvium. It is from this evidence of the direct sequence of terranes, and the relation thus established with subsequent alluviums that, in the failure of the evidence of their fossils, I refer to the Tertiary the grahamite-bearing shales of the Capadero basin. These are probably remnants of the littoral Tertiaries of eastern Mexico and Texas.*

The strike of the fissure is nearly north and south, directly across the river. No attempts have been made to trace it beyond the excavation near the water's edge, its character as a fissure not having been recognized previous to my visit. A length of about 300 feet upon it had at that time been developed.

The sandstone formation is the source of a number of deposits of chapapote or asphaltum. Numerous deposits are said to occur north of the Panuco River. One deposit, which I visited, is found on the Tanelul Ranch, occupying an elevated basin or cul-de-sac between two hills of the Alacranes range, here forming the boundary of the Capadero valley. The point is some 2½ leagues east of the Cristo mine, and *directly in range with the course of the Cristo fissure as far as traced.* The chapapote has accumulated from the evaporation of liquid maltha, which now issues in the form of a sluggish spring with a number of orifices. Here may be witnessed the same process by which the above described overflow of the Cristo mine was originally formed. The source of the chapapote spring is the sandstone above mentioned, on which rest the grahamite-bearing shales of the valley below. It thus appears that the uplifted portions of the underlying sandstone are at present the source of chapapote springs depositing that mineral substance upon the surface. Ancient, and perhaps more copious, springs of the same kind issued from the depressed portions of this formation, and forced their liquid maltha into the fissures and lesser interstices of the overlying shale, which, as I have already stated, is remarkably cleavable and imperfectly indurated. The tendency of such a body of shale or shaly clay, exceedingly fine in texture, to form

* Archiv de la Commission Sc. du Mexique, ii, p. 124.

shrinkage and cleavage partings is well known. Hence this formation, from its nature otherwise impervious, became the permanent receptacle of maltha or asphaltic petroleum, issuing from the sandstone below; and probably the more freely under a hydrostatic pressure, in which water played a part, and the action of which is strikingly suggested by the configuration here observed of a stratigraphical basin bordered by elevated plateaus. The inspissation of maltha or pittasphalt, and even petroleum, to grahamite and other mineral bitumens, by the loss of hydrogen and the addition of oxygen, is a well known occurrence which may be artificially illustrated in the laboratory.* While asphaltum is observed to be the product of the immediate evaporation and oxidation of maltha at or near the surface, a slower and continued oxidation beneath the surface —in fissures, cavities and interstices of the rocks—has produced grahamite, albertite and other less hydrogenous hydrocarbons of the same type.

The smaller exhibitions of grahamite in the shale of the river banks, at Tempoal and the Aguacates, are of the same general nature as the deposit of the Cristo mine. They occupy interstices between divisional planes of the formation, thus forming veinlets which often pass from between one kind of partings to another. Hence even the larger of these deposits or pockets are very capricious in position, while the smaller ones merely reticulate the rock. They seem to have no connection or channels. The question is thus suggested, whether this formation, in places densely filled with organic remains, has not, in part at least, been the primary source of the hydrocarbons which it contains, as well as those of the underlying sandstone, from which, since its emergence, it has been for the most part denuded. This theoretical question must remain open until the relations of the numerous deposits of chapapote in eastern Mexico to the rocks from which they spring, shall be observed and compared. The above small and scattered deposits of grahamite have no economic value—although fine hand specimens can be taken from any of them.

Unlike the New Brunswick variety, which is compact in structure, conchoidal in fracture, and of a resinous and brilliant luster, the Ritchie and Cristo varieties, which are very similar, are of rather granular consistency. They possess a very distinct cleavage, a jointed structure, as well as columnar partings in the deposits, somewhat irregular, on account of the varying conditions of these deposits themselves. The Cristo mineral is more uniformly lustrous than that from Ritchie County, and of a greater coherence, though none the less distinctly cleaved and jointed.

* W. P. Jenny, Am. Chem., v, p. 10.

Both varieties are found at the Aguacates in veinlets. Some of these are filled with a conchoidal variety, like that from the Albert mine, while others consist of the same columnar and sub-conchoidal material as that from the Cristo mine. The conchoidal fracture in both differs simply as to degree, varying with the degree of brittleness.

A few barrels of the mineral from the Cristo mine having been sent last autumn to Glasgow, an analysis and technical examination of the sample were made by Mr. William Wallace, of that city.

ANALYSIS OF CRISTO-GRAHAMITE.

Specific gravity		1·156.	
Volatile matter	Illuminating gas	61·32	62·14
	Sulphur	·46	
	Water	·36	
Coke	Fixed Carbon	31·63	37·86
	Sulphur	·37	
	Ash	5·86	
			100·00

ANALYSIS OF COKE.

Carbon	83·56
Sulphur	·98
Ash	15·48
	100·00

ART. XXXVI.—*On a "Geological Chart of the United States east of the Rocky Mountains, and of Canada;"* by FRANK H. BRADLEY.

IN publishing a new compilation of the general results of geological surveys of the eastern United States and Canada, the writer has felt under obligation to state the reasons for the adoption of any peculiar features of the chart, and also desirous of noting some theoretical points to which this revision of data has called attention.

Mercator's projection was adopted, in order to show most accurately the general trends of the outcrops. The consequent distortion prevented the use of the ordinary mileage scales; but the average scales, for every two degrees, are inserted along the left-hand border.

The scale used is so small that it was impossible to indicate either the very *small* areas of the different formations, or the slighter irregularities of outlines. While this renders the chart inaccurate as regards detail, it has the compensating advantage

of representing with more uniform accuracy areas which have been surveyed with more and with less minuteness.

Considerable portions of the metamorphic areas heretofore mapped as Archæan have recently been proved to be Silurian. These discoveries have cast so much doubt upon the true age of much of the remainder, that I have, in several cases, been unwilling to follow authority in calling it Archæan. The work done in New England by Prof. Dana, and in the Southern States by the writer, has already reduced the Archæan area of the Appalachians by nearly one-half, and has given data for comparison with series of rocks previously described from Virginia, Pennsylvania and New Jersey, which justify the inference that large portions of the metamorphics of these states will also prove to be Silurian. Following this inference, the areas of this region, previously considered Archæan, have been considerably reduced. Much of the uncolored portion of New England is undoubtedly Silurian and Devonian, but with limits which cannot now be determined. Prof. Verrill refers to the Archæan, with much certainty, the belt of red granites running from Mount Desert to the Bay of Chaleur. The Archæan area of northern New York should probably be slightly reduced ;* but the age of the principal part of it seems pretty well determined.

The typical Huronian of Canada, according to description, occupies the position, and presents the lithological characters, which we should naturally expect for the metamorphic portion of the adjoining Lower Silurian, corresponding precisely, in both respects, with extensive beds of that age in the Appalachians. I have accordingly colored them as Lower Silurian. After reaching that conclusion, I learned, through Prof. Selwyn, that Sir William E. Logan held the same view for some time before his death, though it is not, I believe, shared by Prof. Selwyn and his colleagues of the Canada Survey. Prof. Selwyn also informs me that recent work of the Survey has shown a continuation of the Huronian belt north of Lake Huron to beyond Lake Mistassini, with a width of over three hundred miles at one point. Considerable portions of the so-called Archæan area of Wisconsin and Michigan have been shown by Brooks and Pumpelly and others, to be the equivalent of the Canada Huronian, for which reason they might with probability be referred to the Silurian; but the data yet published have seemed so incomplete, that the writer has preferred to leave the area uncolored. Both this and the metamorphic area of Minnesota, as yet unexplored, doubtless include some genuine Archæan.

The metamorphics of Missouri are probably Archæan, and are so colored. Those of Arkansas and part of those of Texas

* Brooks, this Journal, III, iv, 22.

are probably Silurian, but not certainly; those of the Indian Territory have, as yet, yielded no data for a conclusion; all these are therefore uncolored.

Sherwood's results, as published by Hall, will require some changes along the north line of Pennsylvania, in future editions: the data did not reach me until this edition had been struck off.

It has long been held that the Appalachian and the Kentucky-Illinois coal-fields were formed in entirely independent basins, having no communication with each other, and consequently no probable equivalency of coal-seams. A glance at the map, showing the close proximity of the two fields in southern Kentucky, must give anyone strong suspicions that this view is incorrect for that part of the country; and examinations of the two opposing escarpments would strongly confirm the suspicions, though we must probably admit the partial division further north, by the Cincinnati anticlinal. In northern Tennessee, the western face of the Cumberland plateau shows the bold outcrop of about a thousand feet of the coal series in regular horizontal position, with no signs of any abrupt thinning out, as thus far observed. Less than sixty miles, across a continuous outcrop of practically horizontal Subcarboniferous strata, brings us to the eastern escarpment of the western field, where the coal-measures are somewhat thinner, at a slighly lower level, and with a less abrupt outcrop, but still undisturbed and evidently only the continuation of beds which once covered the intervening area. I have long taught this continuity of the two fields; and I understand that Prof. Safford holds the same view, while Dr. Newberry, in conversation, strongly opposes it. How far the union continued southward seems difficult of determination. Judging from the broad western extension of the Coal-measures through Alabama, and of the horizontal Subcarboniferous through Tennessee, to the eastern line of what appears to have been a pre-Cretaceous Mississippi valley, together with the great eastern extension of Coal-measures in Arkansas, to the western margin of the same valley, I am inclined to infer a former continuity of the series across the intervening space of 225 miles, and indeed, over the whole area of lower strata in Tennessee, Arkansas and Missouri, with the possible exception of a few islands, such as Newberry suggests for the Nashville basin, (Ohio Geology, i, 96–110). If the Coal-measures were thus continuous, the erosion of the Mississippi valley must probably be referred to the same age (Jurassic?) as that of the Triassic beds on the Atlantic slope, mentioned below.

Wells, dug through the drift of northwestern Indiana,* have yielded considerable masses of Devonian black shale, hardly displaced from contact with the underlying limestone, in such abundance as to lead to the belief that this bed was for-

* Dr. R. T. Brown, 1869, letter to the writer.

merly continuous across much of the area which, from the known outcrops, we are obliged to color as mainly Upper Silurian. Indeed, it suggests the probability that the Michigan coal-field may once have been continuous with that of Indiana and Illinois; but the surface of that region is so flat and so deeply covered with drift, that it would hardly be *possible* to obtain the data for a *certain* solution of the problem.

Noticing my own neglect of such points, I am led to ask geologists, generally:—Have we paid sufficient attention to the indications of former *probable* extensions of formations over areas where no portions of them now remain?—a point of little practical importance, perhaps, but certainly of great theoretical interest.

I regret that the scale of the map forbids the representation of the numerous trap dikes, probably of Triassic age, which cut across the metamorphics of North Carolina, South Carolina, Georgia and Alabama. The dips of the sandstones and shales in the two Triassic areas of North Carolina give pretty strong evidence of these being only the border remnants of a huge ge-anticlinal, over a hundred miles wide,* (the connecting arch being now removed,) which probably extended far to the southwestward, and possibly over much or all of the area intersected by the trap dikes. Kerr's estimates show the erosionof from 10,000 to 25,000 feet of strata, along the back of the fold; and fully as much must be allowed for, between the New Jersey and Connecticut River areas of Triassic if we accept the opposing dips of these as evidence of another, or part of the same, great ge-anticlinal. There are, it is true, strong objections to this view for the latter region; but no other theory seems to the writer so well fitted to meet the facts.

We have, as yet, no certain evidence of distinctively Jurassic strata on the Atlantic slope of this continent; was then the Jurassic the period during which this enormous folding, eruption (and erosion, in part, at least) took place? For the following Cretaceous has apparently been but very slightly displaced, if at all, except by the pretty uniform secular movements of the continental mass. It may also be questioned whether the Permian period, equally destitute of distinctive deposits along the Atlantic border, was not the era of the upheaval and metamorphism of the Appalachians, which was plainly post-Carboniferous and pre-Triassic.

It seems impossible to indicate fairly the Quaternary beds of the continent upon the same chart with the other formations; since, in one form or another, they cover pretty much the whole surface of the country. The marine beds of the period are too small to be of any importance on a chart of this scale: the river- and lake-border formations are sufficiently well *located*

* Kerr, Geology of North Carolina, i, 141–6, 1875.

by the modern lakes and streams themselves; while, if represented, these and the beds of drift would, over much the larger part of the country, leave exposed only the narrow isolated outcrops of the earlier formations which the learner finds it so difficult to correlate, in his mind's eye, and would show next to nothing of the general structure which it is the main purpose of such a chart to exhibit. Still, charts of the Quaternary continent would be exceedingly instructive, in their exhibition of the old lake-basins and drainage-lines of the continent. Besides the present Great Lakes, with their much greater extent and direct southern outlets, there were at least three great Quaternary lakes, in the Mississippi basin. One has its boundaries well marked by the Lower Silurian outlines of the Nashville basin of Middle Tennessee, its walls being mostly Subcarboniferous. Another occupied the western part of the Silurian basin of Central Kentucky and Southern Indiana, having similar walls on the west, (where its bordering sand-banks lie near the tops of the "Knobs"* fully 400 feet above the Ohio at Louisville,) and stretching far up the slopes of the Cincinnati anticlinal on the east—the boundaries in this direction being as yet unreported. A third occupied a large area on the flats of the Upper Silurian and Devonian areas of Northwestern Indiana;† and perhaps still others swept over the broad prairies of Illinois and the States further west.

Dana has long since called attention to the now-submerged old valley of the Hudson, as marked on the continental border, out to the true edge of the oceanic depression. The lines of soundings along the coast, kindly furnished to me by the officers of the Coast Survey, originally showed a slight bend opposite the mouth of Chesapeake Bay, probably indicating a corresponding notch in the bottom-slopes; but this was overlooked by both the engraver and the proof-reader. In the Gulf of Mexico, the angles of the soundings-lines point directly to Pensacola, the deepest harbor of the Gulf; and this line, continued, meets the Tallapoosa River at its abrupt angle near Montgomery. I have been informed (by Prof. Nicholson, of Knoxville, Tenn., I think) that a broad valley, with high terraces, but now deserted by the river, runs directly south from this angle of the Tallapoosa, as if on a direct course for Pensacola. During the Champlain period, when the streams of all this region were from 170 to 200 feet or more above their present level, this Tallapoosa river received a large share of the drainage of East Tennessee and Western North Carolina; and I have suspected that this old channel was the line of outflow of this great flood, direct to the deep water of the Gulf. The Gulf of Maine and the Gulf of St. Lawrence are well marked by the

* Borden, Geological Survey of Indiana for 1873, p. 181.
† Geology of Illinois, iv, 227.

fathom-lines.* The drift of icebergs, as marked by dots on the small corner-map, shows the source of the material of the "banks" of Newfoundland, and the area over which the growth of the continent is now most actively going forward. It is also evident that the shallowness of the Strait of Belle Isle, which prevents the passage of any but the smallest icebergs, is the principal means of preventing the filling up of the deep channel of the Gulf of St. Lawrence with the sediment now dropped on the "banks."

I shall be under deep obligations to all who will be so kind as to furnish exact data for corrections to be made in future editions of the chart.

ART. XXXVII.—*Observations upon the latest Planetoids;* by C. H. F. PETERS. [From a letter to one of the Editors, dated Litchfield Observatory of Hamilton College, Clinton, N. Y., Sept. 5, 1876.]

As the moonlight now for some days is interfering with observing the small planets, I communicate of the observations hitherto obtained the first and last positions of each, omitting for brevity's sake the intermediate ones. The dates of discovery and the names proposed of these new additions to the group are the following:

(165) *Loreley*, 10·7 magnitude, discovered Aug. 9.
(166) *Rhodope*, 11·2 magnitude, discovered Aug. 15.
(167) *Urda*, 12 magnitude, discovered Aug. 28.

1. Observations of *Loreley:*

1876. Mean time.	α	δ	
	h m s	h m s	
Aug. 9.	10 34 27	21 27 46·57	−10° 0′ 10″·7 (16 comp.)
Aug. 27.	10 26 49	21 13 2·52	−10 13 8·5 (10)

besides observations of Aug. 10, 11, 12, 13, 17, 20, 21, 23.

2. Observations of *Rhodope:*

1876. Mean time.	α	δ	
	h m s	h m s	
Aug. 16.	12 27 2	21 31 24·30	−19° 15′ 16″.1 (14)
Aug. 28.	11 33 39	21 21 55·06	−21 7 20·0 (10)

besides Aug. 17, 20, 21.

3. Observations of *Urda:*

1876. Mean time.	α	δ	
	h m s	h m s	
Aug. 28.	14 18 21	21 58 32·28	−11° 33′ 41″·4 (12)
Aug. 30.	13 35 16	21 57 1·33	−11 23 29·5 (12)

*On the map, by the mistake of the engraver, the 50-fathom line, along the west side of the Gulf of St. Lawrence, is made just like the 100-fathom line.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the Estimation of Nitrogen in Potable Waters.*—Frankland, in a paper on the analysis of potable waters, gives the results of eight additional years of experience with the waters supplied to London. He says that the two chief objects to be kept in view are "the discovery of the evidence of *past* pollution by organic matter and the quantitative determination of *present* or actual organic impurity." With reference to the first point, he gives his opinion that the presence of nitrogen in the forms of nitrates, nitrites and ammonia in potable waters, in quantity above that which can be derived from rain, is reasonably safe and trustworthy evidence of the previous pollution of that water by animal matters. As to the second, he shows that, of the four processes proposed for determining organic constituents, known as the ignition, the permanganate, the albuminoid-ammonia and the combustion methods, the two first are quite useless; of the third he concludes from the extended experiments made by himself and others: 1st, that it affords no evidence whatever of the absolute quantity, either of organic matter or of organic nitrogen, present in potable water; 2d, that it does not indicate, even approximately, the relative quantities either of organic matter or of organic nitrogen in different samples of such water; 3d, that it affords no indication either of the presence or of the proportion of albuminoid as distinguished from other nitrogenous organic compounds; and 4th, that it is entirely useless therefore in the examination of waters for sanitary purposes. The combustion process, however, devised by himself nine years ago, he believes to be reliable. He claims for it: 1st, that it is the only method at present known which affords any trustworthy information respecting the organic matters present in potable waters; 2d, that it is the only method which even professes to determine organic carbon in such waters; 3d, that the determinations by it of organic carbon and nitrogen are fairly accurate, notwithstanding the very minute quantities of matters dealt with; and that the errors, even of a comparatively inexperienced analyst are far within the limits which would affect a verdict upon the quality of the water submitted to investigation; 4th, that it is the only process which discloses the proportion of nitrogen to carbon in the organic matter of waters, such information being often of prime importance in reference to the origin of the organic matter; and 5th, that since the modifications which have been made in the mode of evaporation the process can now be conducted in any laboratory and with a moderate expenditure of time and labor.—*J. Ch. Soc.*, clxii, 825, June, 1876.

G. F. B.

2. *On the Absorption of Nitrogen by Organic substances.*—Berthelot has found that pure nitrogen gas is absorbed by or-

ganic bodies at the ordinary temperature, under the influence of the silent electric discharge. Benzene, for example, absorbed, for every gram used, four or five cubic centimeters of nitrogen; the benzene being exposed either in vapor or in very thin layers of liquid. A condensed, polymerized compound resembling a resin, collected on the sides of the tube, which evolved ammonia when heated. Turpentine, marsh gas and acetylene act similarly. Filter paper slightly moistened, absorbs notable quantities of nitrogen, when thus treated, which is set free as ammonia on combustion with soda-lime. The same fact was observed with dextrin. Since neither nitrates or nitrites nor ammonia is produced, the author believes that a complex nitrogenous compound is formed by the direct union of the free nitrogen with the substance employed. He considered these facts of importance relative to the fixation of atmospheric nitrogen in nature.—*Bull. Soc. Ch.*, II, xxvi, 58, July, 1876. G. F. B.

3. *Action of the Copper-zinc Couple on Chlorates and Perchlorates.*—Eccles, working under Thorpe's direction, finds that potassium chlorate is easily and completely reduced to chloride by the action upon its solution at the boiling temperature, of a properly made zinc-copper couple; so that an accurate quantitative method may be based on it. Potassium perchlorate, however, undergoes no change under these conditions. This fact the author has made excellent use of, to prove that the decomposition of the chlorate by heat takes place in two stages, in the first of which perchlorate is produced. The progress of the decomposition may also be accurately studied in this way. No perchlorate is formed, however, if manganese dioxide be added to the chlorate.—*J. Ch. Soc.*, clxii, 856, June, 1876. G. F. B.

4. *On a supposed shifting of Atoms.*—Demole has examined critically the substance obtained by Baumstark by the action of an alcoholic solution of iodine upon ethylene, to which he assigned the formula C_4H_9IO, and which he supposed to be ethylidene-iod-ethylin. The improbability of the ethylene grouping being changed to that of ethylidene by this simple action, led Demole to prepare the ethylene compound synthetically with a view to compare its properties with those of the new body. For this purpose, mono-ethyl-glycol was prepared, and treated with phosphorus iodide. The reaction is:

$$\left(\begin{cases} CH_2OH \\ CH_2OC_2H_5 \end{cases}\right)_3 + PI_3 = \left(\begin{cases} CH_2I \\ CH_2OC_2H_5 \end{cases}\right)_3 + P(OH)_3.$$

The substance thus obtained was found to be identical in its properties with that obtained by Baumstark. His body is, therefore, ethylene-iod-ethylin. By the action of sodium-ethylate on it, acetal is produced.—*Ber. Berl. Chem. Ges.*, ix, 743, June, 1876. G. F. B.

5. *On Crystallized Glycerin.*—Van Hamel Roos has examined a quantity of fifty-six pounds of crystallized glycerin. The crystals are monoclinic, perfectly colorless, and of a pure sweet taste.

Placed in ordinary good glycerin, they cause the formation in it of magnificent crystals. When melted at 60° F. the liquid has a specific gravity of 1·261. This cooled to 30° F. solidifies easily by the introduction of a small crystal of glycerin. At 24° F., the solidification is spontaneous after some time, though agitation seems to be indispensable. The melted glycerin is much less easily fermented, and hydrocyanic acid is without action upon it Since the crystallization of glycerin depends on its being pure and anhydrous, the formation of crystals is the best test of purity, and at the same time the best method of purification.—*J. Chem. Soc.*, clxi, 651, May, 1876. G. F. B.

6. *On the Lactic acid obtained from Inosite.*—Scheerer, the discoverer of inosite, mentions its breaking up by fermentation into lactic acid. Vohl, the discoverer of phaseomannite, which he subsequently proved to be identical with inosite, also proved the identity of the lactic acid from this substance, with the ordinary lactic acid of fermentation. This statement having been called in question by Hilger, Vohl fermented 250 grams inosite dissolved in two liters of water, by the aid of putrid cheese with the addition of chalk, at a temperature of 25° to 28° R. The thick mass of calcium lactate was treated with animal charcoal, boiled and filtered hot. On cooling, calcium lactate crystallized out and was purified by repeated crystallization. These crystals had 29·098 per cent crystal water; the salt of common lactic acid contains 29·221, that of sarcolactic acid 21·721. The zinc salt gave 18·104 per cent water, the quantities of the two salts respectively being 18·178 and 12·901. Moreover, the insolubility of the zinc salt showed it to be common lactate. Oxidation yielded acetic and formic but not a trace of malonic acid.—*Ber. Berl. Chem. Ges.*, ix, 984, July, 1876. G. F. B.

7. *Synthesis of Polybasic Acids by the action of Carbon dioxide on Salicylic acid.*—Ost finds that by passing a stream of dry carbon dioxide gas over basic sodium salicylate, the gas is absorbed and an acid formed having the formula $C_6\begin{matrix}H_3\,COOH\\OH\,COOH\end{matrix}$ which he calls ortho-phenol-dicarbonic acid. A similar tricarbonic acid is also formed in this way.—*J. pr. Ch.*, II, xiv, 93, July, 1876. G. F. B.

8. *Freezing of Colloids.*—Prof. Guthrie described to the London Physical Society some experiments on the freezing of aqueous solutions of colloid substances, which he has been studying in connection with his recent investigation on cryohydrates, etc. If a solution of sugar be gradually cooled, the temperature at which ice separates out is always below 0° C. and the extent below increases with the amount of sugar in solution; but he finds that in a solution of gum having exactly the same chemical formula, the ice always separates at 0° C. whatever be the amount of gum present. Thus while every crystalline substance forms a freezing mixture when mixed with ice or snow, colloids are incapable of doing so. The gum and the water do not recognize each other;

and similar results were obtained in the case of gelatine and albumen. These facts are strictly in accordance with the results of Prof. Graham's classical researches. It also follows that, when heated, similar effects are observed, and Prof. Guthrie has found that solutions of gum in varying proportions always boil at 100° C. —*Nature*, xiv, 264. E. C. P.

9. *Explosion of Fire Damp.*—M. MALLARD has measured the velocity of inflammation of various mixtures of fire-damp and air. Various mixtures were set in motion with different velocities, and that velocity at which the zone of combustion remained stationary measured the velocity sought. The highest velocity of inflammation was 560 meters per second, and it occurred in a mixture of 0·108 vol. of fire-damp in one volume of the mixture. On increasing or diminishing the proportion of fire-damp, the velocity in question diminished very rapidly, becoming *nil* with a proportion of ·077 vol. on the one hand, and 0·165 vol. on the other, below which the mixtures are neither explosive or inflammable. It is notable that a variation of even 0·01 in the proportion of fire-damp is sufficient to convert an absolutely indifferent mixture into a highly dangerous one.—*Naturforscher*, Feb., 1876; *Nature*, xiv, 202. E. C. P.

10. *Velocity of Electricity.*—Dr. W. SIEMENS has measured the velocity of propagation of electricity in land telegraph lines by the following apparatus: two condensers have their outer terminals connected by a metallic wire. Their inner terminals are attached to two points placed near a registering cylinder connected with the earth. The connection for one point is a short wire, and for the other a telegraph line. The two condensers are discharged simultaneously by connecting their outer terminals with the earth when the cylinder gives the interval which has elapsed between the two sparks. Instead of the telegraph line a rubber tube thirty meters long and twenty millimeters in diameter and filled with sulphate of zinc was first used. The interval between the discharges was inappreciable, and certainly did not exceed five millionths of a second. With a line 25·36 kms. long, the retardation was 125-millionths; with another of 23·37 kms. the retardation was 101-millionths, and with a third of 7·35 kms., thirty millionths. These times are nearly proportional to the length of the lines. The capacity of the two shorter lines was ·15 and ·063 microfarads and their resistance eight Siemens per kilometer. The retardation by comparison with that of condensers of known capacity ought to be only two millionths of a second. Thus the retardation observed is much greater than that required to charge the cable and is not proportional to the square of the length. M. Siemens concluded from this that the electricity has really a velocity of propagation. It must be remarked, however, that the insulation of the lines was not observed, and that slight leakages through the supports would have the effect of increasing the time necessary to charge the line, and of rendering it more nearly proportional to the length.—*Pogg. Ann.*, clvii, 309; *Journ. de Phys.*, v, 226.

E. C. P.

11. *Polarization Currents.*—MM. SCHILLER AND CALLEY describe an experiment showing the electro-dynamic action of a polarization current. It is well known that water cannot be decomposed by a single Daniell's cell; but if a voltameter and galvanometer are inserted in the circuit of such a cell the needle deviates at the moment of making or breaking the circuit. These well known facts have led some persons to compare a voltameter to a condenser of great capacity. The question is to determine whether the liquid conductor can exercise an electro-dynamic action while the electrodes are being charged. *A priori*, this is not self-evident, but is established by the following experiment. In a Wiedemann's galvanometer, one of the bobbins was replaced by a coil formed of a rubber tube filled with water free from air and slightly acidulated. The coil consisted of thirteen turns six centimeters in diameter. The resistance was 1600 Siemens. The two bobbins (one metallic, the other liquid) were so placed that the current of four Daniell cells traversing both at the same time and decomposing water did not deviate the needle. The four cells were then replaced by a single one. On closing the circuit no deviation was observed but on removing the metallic bobbin a deflection was obtained amounting in the first swing to twenty divisions.—*Journ. de Phys.*, v, 261. E. C. P.

12. *Magnetic Induction.*—M. CHWOLSON presents a second valuable memoir on the mechanism of magnetic induction, which process he seeks to explain by the supposed existence of molecular magnets which are turned by the external force in one direction. In his former paper he dealt with the case of temporary induction in soft iron; he here treats of magnetic induction in steel. The paper is in five chapters; in the first are summarized the results obtained by previous observers, those of Jamin being given with special fulness. In the second the author describes his experiments, which require a modification of Jamin's theory. Of Jamin's two laws relating to the action of positive and negative currents or permanently magnetized bars, Mr. Chwolson finds the first absolutely correct; the second incorrect. Jamin's mistake he considers to be in the supposition that the negative current acts only on the surface layers, leaving those below untouched; it is shown on the contrary, that the least negative current acts on all the layers and diminishes their intensity. Then he gives a mathematical theory of induction in steel; supposed the first attempt of the kind (if Maxwell's but partly successful one be excepted). In the fourth chapter he explains, on the basis of theory, the various experimental results got by different observers; and in the fifth shows how certain results that might, *à priori*, be foreseen from the theory, have been verified.—*Pogg. Ann. Erganz.*, vii, 4; *Nature*, xiv, 202. E. C. P.

13. *Constants of Nature.* Parts II and III, and first supplement to Part I. Compiled by F. W. CLARK, Prof. of Chem. Univ. Cincinnati. 1876. Washington. Smithsonian Misc. Collections, Nos. 276, 287, 288. Part II of Prof. Clark's thorough and very

useful work, includes a table of specific heats for solids and liquids; Part III, tables of expansion by heat for solids and liquids; and the Supplement to Part I, specific gravities, boiling points, and melting points.

II. Geology and Mineralogy.

1. *On the Age of the Vertebrate Fauna of the Eocene of New Mexico;* by Prof. Cope. (Proc. Acad. Nat. Sci. Philad. for April, 1876.)—Comparison with the established scale of geological horizons of Europe has established the fact that the beds in question belong to the Eocene category, as I have already shown* to be true of the longer-known Bridger beds of Wyoming. It remains to collate them with the numerous subdivisions of that period. The differences between the Wahsatch and Bridger faunæ have been in part pointed out in my Report on the Vertebrate Fossils of New Mexico,† 1874, and may be more fully stated as follows:

(1) Divisions found in the Wahsatch beds not yet reported from the Bridger beds. Aves, genus *Diatryma* (allied to *Gastornis*); mammalia, *Tæniodonta; Phenacodus; Coryphodon;*‡ *Meniscotherium;* most species of *Hyracotherium.*

(2) Divisions found in the Bridger beds not yet found in the Wahsatch: fishes, *Amiidæ;* reptiles, *Ophidia; Anostira;* mammals, *Mesonychiidæ; Tillodontia; Achænodon; Dinocerata; Palæosyops;* most species of *Hyrachyus.*

The Wahsatch horizon of Wyoming has not yielded so many species of vertebrata as those of New Mexico,§ but the close resemblance of the two faunæ may be observed in the following list of forms which I obtained at several localities: Fishes, *Siluroids;* mammals, *Hyracotherium*, two species; *Phenacodus; Coryphodon*, two to three species. As is well known, the Wahsatch beds underlie those of the Bridger group, and we therefore look for their European equivalent in the lower part of the series. It has been already pointed out‖ that the absence of *Hyopotamus* and *Anoplotherium*, and allied genera, from the Bridger horizon, precludes an identification with the Upper Eocene of Europe. The comparison of the Wahsatch fauna with that of the lowest of the three divisions into which Professor Gervais has arranged the European Eocene, shows a remarkably close correspondence. This epoch, the Suessonien of D'Orbigny (Orthrocene, Gervais), includes the marls of Rilly and lignites of Soissons, the Thanet sands, London clays, etc. Fossils from these beds appear to have been no better preserved than those of the Wahsatch beds of the Rocky

* Proceedings American Philosophical Society, 1872, February and July.

† Annual Report of Chief of Engineers, p. 592.

‡ The species described by me as *Bathmodon* constitute a section of this genus, characterized by the absence of tubercle or ridge between the inner cusps of the last lower molar. I do not maintain this section as a distinct genus.

§ See Report of the U. S. Geol. Surv. Terrs., 4to, ii, pp. 33–39.

‖ Ann. Report U. S. Geol. Surv. Terrs., 1873 (1874).

Mountains, yet some of the genera are identical, and others closely correspondent, as follows:—

Wahsatch.	Suessonien.
Ambloctonus.	Palæonyctis.
Hyracotherium.	Hyracotherium.
Coryphodon.	Coryphodon.
Diatryma.	Gastornis.
Lepidosteus.	Lepidosteus.

As a point of difference between the beds, may be mentioned the absence of the *Tæniodonta* from the Suessonian, a sub-order not yet known out of North America.

The Wahsatch formation includes the Green River Beds of Hayden, a name which I formerly used for the entire series. It, however, applies properly to the fish shales of Green River, containing *Asineops*, *Clupea*, *Osteoglossum*, etc., which are probably local in their character.

The Bridger formation will then represent on the American continent, more nearly than any other, the Middle Eocene or Parisien of Cuvier, Brongniart, and Renevier.

The teeth of sharks described in the reports quoted are of uncertain origin. They are associated with oyster shells, and both have the appearance of having been transported; nevertheless, some of the mammalian teeth found associated with them have a similarly rolled appearance. It therefore remains uncertain whether the ocean had for a limited time access to the Eocene lake, or whether the shark's teeth and *Ostreæ* were derived from the Cretaceous beds which formed its shores. Similar, and in one instance the same species of sharks were found in both formations, the division of the Cretaceous being No. 3 and 4 of Hayden.*

In conclusion, the classification of the North American Eocene may be represented as follows:—

Formation.	Equivalent.	Locality.	Characteristic Fossils.
Bridger Form.	Middle Eocene.	S. W. Wyoming.	Palæosyops. Tillodontia. Dinocerata.
Wahsatch Form.	Lower Eocene.	N. E. New Mexico, S. W. Wyoming.	Coryphodon. Tæniodonta. Phenacodus. Diatryma.

2. *Note upon the Geological position of the Serpentine Limestone of Northern New York, and an inquiry regarding the relations of this Limestone to the Eozoon Limestones of Canada*, by Prof. James Hall.—(The following is an abstract of this paper read before the American Association at Buffalo.) On the geological map of the State of New York now before you, you will observe a large area in the northern part of the State, colored of a light reddish tint. The formations occupying this space were originally termed Primary, and more recently Laurentian. They constitute

* The same state of things exists in the siderolitic deposits of the Canton of Vaud, Switzerland. Mingled with the mammalian remains are teeth of sharks, of which M. La Harpe remarks that their appearance does not warrant the belief that they have been transported, or are not indigenous to the Eocene fauna.

the oldest rock formations of the State, as well as of the eastern part of the continent, although we well know that they represent several geological periods.

The counties of Essex, Warren and Hamilton are almost entirely occupied by rocks of the Laurentian system proper, while a large part of Clinton, Franklin, and a considerable portion of Saratoga and Herkimer, are occupied by the same geological formations.

The eastern part of Saratoga and Warren and the shore of Lake Champlain, in Essex and Clinton counties, are marked by the presence of the Postdam and Calciferous sandstone and the Chazy and Trenton Limestones, one or all of them; and the northern part of Clinton presents a broad outlying area of the Potsdam sandstone, which stretches westward across Franklin and St. Lawrence counties and thence into Canada.

The rocks of the lower division of the Laurentians consist of black hornblendic, gray garnetiferous and coarse feldspathic and quartzose gneisses, with extensive beds of magnetic iron ore. These are succeeded by massive beds of labradorite rock—the hypersthene rock of Emmons and other granite rocks. This part of the formation is marked by extensive beds of titaniferous iron ore. The succession is however unconformable, and the interval between the two series of rocks is not determined, nor does it appear to be determinable from examinations thus far made within the State of New York.

Associated with these gneissic and labradorite formations are one or more bands of crystalline limestone—the primary limestone of Emmons. This limestone is usually and perhaps always permeated by serpentine in grains, bands, or what sometimes appear as concretionary or aggregated masses of that mineral. This limestone in the eastern counties of northern New York has been considered a part of the Laurentian series, and is thus treated I believe by all geologists.

Having, in 1866, been occupied in some critical examinations of the region in the neighborhood of Port Henry and Westport, I became satisfied that the limestone of that neighborhood did not form a part of the lower Laurentian series of strata, but unconformably overlaid the upturned edges of the gneissic beds of that portion of the system. Neither does it conform to the upper or labradorite portion of the system. Having had occasion to pass over the same region almost annually since that period I have been confirmed in my previous observations.

The limestone in the neighborhood of Port Henry is usually a heavy bedded crystalline limestone with grains and blotches, and more rarely layers of serpentine. Sometimes it is conspicuously brecciated, and contains fragments of gneissoid rock which seem to have been derived from the strata below, upon which the rock lies unconformably. The same belt of limestone occurs at intervals, flanking the Laurentian rocks to the southward, and is conspicuously present in the town of Minerva, and it is apparently the same belt which is known in Warren county. From the latter ocality it has been reported as containing Eozoon.

The limestones of St. Lawrence and Lewis counties are usually more coarsely crystalline, with larger bands of serpentine, and with a somewhat different association of minerals, from those of the eastern counties, and the identity of the two is not proven. Nevertheless these limestones, last referred to, with their associated beds of granitic and other rocks, with specular iron-ore, are not of true Laurentian age, and their relations to the latter are at present not well determined, except that they are of more recent date in the geological series.

The simple point which I wish to demonstrate is that this limestone of Essex and adjacent counties does not belong to the Laurentian system, either lower or upper. That it is a formation deposited along the flanks of, and within the Laurentian area, at a period subsequent to the deposition, metamorphism and disturbance of the rocks of authentic Laurentian age, and that it apparently holds a place in the series between the Laurentian and Potsdam periods, but whether of Huronian age or otherwise I do not pretend to say, and it may even prove of later date than this.

With these facts before us it becomes a matter worthy of inquiry, whether the Eozoon limestones of Canada, which are associated with Laurentian rocks and have been referred to that age, are really Laurentian, or hold the place and position of those of Northern New York.

NOTE.—Since preparing the statement giving views here presented, I have been informed that Mr. Vennor, of the Canadian Geological Survey, in a paper read before the Natural History Society of Montreal, has expressed an opinion that the Eozoon limestones of Canada are not of Laurentian age. Not having seen the communication I am only able, at the present time to add this note, but with the permission of the Association will make a more extended reference in the final publication.—*Buffalo Courier*, Aug. 25.

3. *On the Geology of the Southern Counties of New York and adjacent parts of Pennsylvania, especially with reference to the Age and Structure of the Catskill Mountain Range;* by JAMES HALL (Proc. Amer. Assoc., 1875, p. 80).—The object of this paper is mainly to state and illustrate the results of four years of labor, chiefly in the southern counties of New York and the adjacent northern portions of Pennsylvania, by Mr. Andrew Sherwood, assisted by Mr. Clark Sherwood, under my direction.

The question has been raised regarding the existence of the Old Red Sandstone, or Catskill group, within the limits of New York, although a considerable area had been thus colored on the original geological map of the State.

The assertion of the non-existence of this formation in the State had induced me many years since to review some portions of my work of 1844, and, while in the main features it was found correct, it became evident that something farther was needed in the elucidation of the structure of the Catskill region. In fact, it became evident that one could travel from Schoharie county to the Penn-

sylvania line, on rocks of the Chemung group, without touching or seeing the Old Red Sandstone. And from this circumstance arose the statement of the absence of this formation from the State of New York. It became a very different matter, however, when one crossed the same region of country from east to west.

After several visits to this region, and notably one in 1857, with Sir William E. Logan and Andrew C. Ramsay, (the latter now Director of the British Geological Survey,) the question of the geological age of this great accumulation of strata assumed a still more important aspect; and the question has never been lost sight of; though for many years it has been quite impossible for me to undertake the investigation.

Referring to the Geological Map of New York, of 1843, a large area is colored as the Catskill Group without indication of geological structure. A similar feature was seen in northern New York; where the limits of the Laurentian system had barely been determined. Geological surveys have been carried on with too much haste, and under the pressure of necessity, from limited time; therefore it was, that we were compelled to content ourselves with determining the limits of formations, and not the structure, which required long and careful investigation.

In 1870, when for the first time I was able to give attention to this part of the country, there was no definite knowledge of the region; the record of the Geological Map had been controverted; and the non-existence of the Catskill or Old Red Sandstone, within the State of New York, was the prevalent opinion.

Mr. Sherwood was employed to begin his investigations in the spring of 1871, and has continued till the close of 1874. To accomplish the work represented on the map before you has, therefore, cost the labor of two men for four years. It now presents the aspect of a piece of work completed, except that from the erroneous maps of the State we are unable to give more than the approximate limits of the outcrops.

The work has not only accomplished what was undertaken, but has proved conclusively the existence (first suspected in 1857) of higher formations, lying upon the red Catskill rocks.

The entire region, from the base of the Catskill range to the western limits of the red rocks, in Chenango county, presents a series of nearly parallel anticlinal and synclinal folds; and the same structure is continued to the western limit of the State, although the red rocks may not appear within the State; and the formation probably thins out entirely, before reaching the western boundary of New York and Pennsylvania.

The topographical sketch presents a view of the Catskill range from the east side of the Hudson river, opposite to Catskill, looking over the shales of the Hudson River Group; the general dip of the rocks is perceptible in their inclination to the southward. In a cross section of this range, the dip of the strata to the northwest and southeast is shown, forming synclinal and anticlinal folds, of which five synclinals and six anticlinals are included in the extent given.

The expression of the map in its coloring shows the direction and extent of certain belts of red rock, which in some part of their extent are crowned by gray sandstone and conglomerate, referred to the Vespertine and Umbral formations of Professor Rogers, and regarded as belonging to the Carboniferous age.

These belts are the synclinal axes, which sometimes embrace the higher rocks within their folds, and have, in some localities, been so far eroded as to leave only a narrow belt of red rock; and even this has been in many places removed, and the erosion has penetrated deeply into the rocks of the Chemung Group.

Going to the south of the State line, these synclinals carry outliers of the Coal-measure, greater or less in extent, as shown by the map. In the Catskill region the general direction of these synclinals and adjacent anticlinals is from southwest to northeast; but farther to the westward they gradually decline in abruptness, and assume a more nearly east and west direction.

The anticlinals are everywhere valleys, along which the streams flow and the main roads of the country are made; the road from Kingston to Delhi being the principal exception. In going to the east or west of these we ascend over the rough and broken country formed by the outcropping of the Red Sandstone and Conglomerate. Owing to the great difficulty of crossing this country, we have long remained ignorant of its geological structure. The synclinals everywhere present high and broken ridges, and more especially so when the Vespertine and Umbral rocks form the terminal mass.

It is true that the Delaware and Susquehanna rivers both flow across or through these synclinals, in channels made by deep erosion.

The parallel ridges of the high country culminate in the Catskill mountains, where we have an elevation of nearly 4,000 feet above tide-water. The cause of this greater elevation is shown to be due to the convergence of three synclinals, which, presenting such a mass of material to the eroding forces, has prevented the anticlinals from being excavated below the red rocks of the Catskill formation. To this condition we are indebted for the higher portions of the range, which present, in a topographical aspect, only an irregularly scattered mass of mountain elevations.

The section exhibited, crossing the Catskill range from Schenevus to Glasco, is on a line south of the culminating ridges, and therefore does not present the highest points of the range. The lower rocks of the section are of the Chemung Group; but the relations of all these are shown on the smaller section from the Mohawk to Carbondale.

The lower beds shown, of Portage and Chemung, have a thickness of more than 2,000 feet; while the rocks above, which may be referred to the Catskill, are about 3,000 feet thick, and the higher beds, of Vespertine, extending to the summit of Round-Top, may be reckoned at about 800 feet.*

* That the entire mountain elevation above tide-water does not exceed 4,000 feet, is due to the dip of the strata, which makes the elevation so much less than the thickness.

The passage from the red rocks to the gray sandstone and conglomerate is gradual, with alternations of red and gray rocks, and does not afford any strong line of demarcation.

The remains of *Holoptychius*, in the form of bony plates, fragments of bone, etc., extend through a thickness of more than two hundred feet.

In its western extension, the red rock, with its alternations of green and mottled beds, shows a gradual thinning, and finally seems to be lost entirely.

One of the greatest difficulties met with in this investigation, has been the occurrence of red and greenish shales in the Chemung and Portage beds; and the finding of gray beds with Chemung fossils at an elevation of at least one hundred and fifty feet above the base of the red rocks, which had always been referred to the Catskill formation.

We have finally, however, ascertained, as I believe, the limits of the formation, and though not always in strong contrast with the rocks below, we have been guided both by physical and biological conditions.

In the interval between well-marked Chemung and typical Catskill, there are beds of intermediate character, and we sometimes find a few fossils of the lower rocks. The same means of distinction do not occur in all localities. In some places the indications of the Catskill are in the red shales and diagonally laminated sandstones. In other places we find a mass of vegetation, with or without the presence of the large Lamellibranch known as *Cypricardites Catskillensis.* The occurrence of this fossil may, in my opinion, be relied on as characterizing the base of the Catskill formation, while the *Holoptychius* marks the beds above, but still is not known above the middle of the formation.

Another question, involved in this investigation, has been the determinations of the relations of these red rocks to the superior sandstones and conglomerates, which in eastern New York and Pennsylvania are known as Vespertine and Umbral. The question also as to the character of these latter rocks in their western extension, is one of great interest, and whether the Waverly sandstones of Ohio may or may not be a continuation of the former.

In some localities in the border counties of western Pennsylvania, the rocks regarded as the Waverly Group of Ohio, rest directly upon the Chemung; and the fossils of the Chemung pass into the higher beds and mingle with other species regarded as Carboniferous forms.

Indeed, from the little I have seen, I should say, that in the region referred to, there are more species of fossils passing from the Upper Chemung into the Waverly formation, than there are species passing from the lower to the upper division of the Chemung group proper.

The question is of great interest in view of the supposed horizon of Carboniferous forms; but if we are able to substantiate the foregoing proposition, I think it will be shown that the Chemung

fauna continued its existence till after the appearance of Carboniferous forms, and that the two faunas, if they can be properly so regarded, lived in the same sea and at the same epoch; and the question of the limits between Devonian and Carboniferous formations, is likely, at least for some time, to remain undetermined in some parts of the country.

The work is still unfinished in the western part of the State; but we have indications of what we may expect to find on farther investigation.—*Proc. Amer. Assoc.*, Detroit, 1875, p. 80.

4. *On the Erosion of Rocks;* by E. B. ANDREWS. (Communication to the Editors, dated Lancaster, Ohio, Sept., 1876.)—Attention having been recently called to the subject of erosion by the excellent papers of Mr. G. K. Gilbert, I beg a little space to present one feature of the weathering of rocks, which may be worthy of more consideration than it has received.

In some counties in Ohio, where the Waverly sandstone assumes a coarse semi-conglomeratic character, and in our Coal-measures where the sand rock is coarse and massive, we find many narrow valleys bordered by high cliffs, from fifty to two hundred feet high. These cliffs often overhang their bases forming recesses of from thirty to one hundred and fifty feet in depth from a vertical line dropped from the top. These rock-walled valleys when followed up are often found to terminate in semi-circular cliffs over which the little streams fall in pretty cascades. Behind the falls we find large semi-circular or crescent-shaped caverns, forming recesses sometimes large enough to hold regiments of men. The streams are generally very small and often become dry in the summer. They have worn for themselves only slight channels in the top rock,—the rock-roof of the cavern—but the point where the water strikes below is too far away from the side walls of the cavern to admit of any direct erosion, or of any mechanical undermining of the cliff. Ordinarily the whole range of the cavern wall is dry. But not so in time of freshet. Then the water comes down with great force of concussion, and the cavern becomes a "cave of the winds." The spray is driven into the inmost recesses and the moisture with the help of frost disintegrates the rocks. This spray from muddy waters leaves a coating of mud upon the walls of the cavern. Thus spray becomes the agent of undermining the cliff, just as the coal-miner makes his "bearing-in" in the lower part of the coal seam. In time, the projecting table-rocks fall and the valley is practically formed. In this way an enormous amount of valley erosion has been produced in sandstone regions.* A fine illustration of valley-making by means of a spray-formed cavern may be seen near the "Ash Cave," in the western part of Hocking County, Ohio. The Ash Cave is itself only a remnant of a spray-cavern. The overhanging cliff formed a dry and desirable shelter, and the recess was long

* The erosion at the Falls of Niagara, by spray driven by wind against the shale, is referred to by Lyell, in his account of the region given in his "Travels in North America," page 26, and also by Prof. James Hall in his New York Geological Report.

used by Indians, who have left upon its floor a large accumulation of the ashes of their fires,—a pile 100 feet long by perhaps 30 feet wide, and two and a half feet deep,—in which I have found buried human bones, seeds, and many Indian relics. The water-fall, with its semi-circular cavern, is a hundred rods above the Ash Cave. A similar large spray cavern is found on a small tributary of Salt Creek, a few miles below Jackson, in Jackson County. Here the rock is a Coal-measure conglomerate. I have seen hundreds of these caverns in coarse heavy-bedded sandrocks of the West.

It may be well to add to the foregoing statement the fact that there are, in the Waverly sandstone region, numberless valleys with terminal circular arched cliffs, which in the retrocession of the falls have been carried so far back toward the top or center of the dividing ridges as to leave for themselves drainage areas quite too small to afford water enough to continue the work of cañon-making. The streams, being only small affluents of the larger ones, and often not more than half a mile long, were at first large enough, when in freshet, to make the spray caverns and to remove the waste at the foot of the terminal cliffs. But now, with drainage area above the falls reduced to almost nothing, the water, even in its highest stage, is too feeble a porter to carry away the waste, and the heads of the cañons are slowly filling up from local disintegration, etc. The famous Rock House, in Hocking County—pictured in Ohio Geol. Report for 1870, p. 83—is an illustration of cañon-making in its last stages. The little stream, which has worked out the cañon, is probably not more than half a mile long from head to outlet, and of this length three-quarters are below the falls. The terminal cliff is 115 feet high. This cliff is near the summit of a hill, and the drainage of very few acres forms the insignificant brooklet that trickles over the edge and down the face of the rock. The whole length of the top edge of the cliff from side to side of the chasm is probably not less than 500 feet. The streamlet which, when I saw it, a child might almost divert from its course by a shingle, has changed its place from time to time, and so has operated along the whole face of the cliff. At the point back of the spot where the waters, when in freshet, must now strike the bottom is a small recess, formed by the weathering action of the spray. A small channel is kept open below the falls, but the stream is able now to carry away only a small part of the waste of the cliff and the wash of the soil above the cliff, and the work of filling up has begun. The Rock House, proper, is a magnificent corridor high up in the cliff, formed by the action of the little stream passing down a crack parallel to the face of the rock and finding outlets in transverse cracks.

5. *Report on the Geology of the Eastern portion of the Uinta Mountains, and a region of country adjacent thereto;* by J. W. Powell. 218 pp. 4to., with plates and sections, and also a folio atlas. Washington, 1876.—Major Powell, in this sequel to his Report on the Colorado region published in 1875, embraces, be-

sides the results of his study of the Uinta Mountains, a general consideration of the wide range of facts he has observed in the West. He gives, in systematic form, the views he has arrived at with regard to the nature of the mountain structures of the region, and the system in the faults, folds, and displacements of the rocks; also detailed sections of the series of sedimentary strata involved in the displacements, from the lowest rocks to the top of the Tertiary, and the distribution of these rocks in the Uinta Mountains; finally, he treats of the special structure of these mountains, and of the methods and results of their degradation. The subject of displacements is admirably illustrated by his plates, two of which are stereographic; and, owing to the bare condition of the surface, the facts have been made out with an exactness and amount of detail impossible in regions of soil and forests. An excellent feature of the work is the natural scale of all its sections, in place of the usual exaggerations. The views are partly those adopted by Mr. Gilbert. We propose to cite at length from the volume in another number of this Journal. The Report also contains a Paleontological Report by Prof. C. A. White, treating of Carboniferous, Jurassic, Cretaceous and Tertiary Invertebrate fossils, some of them new species.

6. *On a Gigantic Bird from the Eocene of New Mexico*, by Prof. COPE. (Proc. Acad. N. S. Philad., Feb., 1876.)—Prof. Cope exhibited a tarsometatarsus of a bird, discovered by himself during the explorations in New Mexico conducted by Lieut. G. M. Wheeler, U. S. A. The characters of its proximal extremity resemble in many points those of the order *Cursores* (represented by the *Struthionidæ* and *Dinornis*), while those of the distal end are, in the middle and inner trochleæ, like those of the *Gastornis* of the Paris Basin. Its size indicates a species with feet twice the bulk of those of the ostrich. The discovery introduces this group of birds to the known faunæ of North America recent and extinct, and demonstrates that this continent has not been destitute of the gigantic forms of birds, heretofore chiefly found in the Southern Hemisphere faunæ. The description is as follows:

The hypotarsus is moderately prominent, with a broad truncate face, and does not inclose the ligamentous groove of its inner side. Its superior angle is broken away in the specimen. The two foramina which pierce the shaft just below the head, are well separated from each other both on the posterior and anterior faces, marking nearly equal thirds of the transverse diameter of the bone. The cotyloid cavities for the tibio-tarsus are bounded by an elevated margin, and are separated medially by a single low oblique ridge. The groove of the posterior face is particularly wide, and the inner part of the shaft is thinned, while the outer border is broadly convex. The proximal part of the inner border (as far as it is preserved) is marked with a flat surface which is roughened with ridges, which is perhaps the sutural articulation of the proximal end of the metatarsus of the hallux. No such surface exists on the corresponding bone of the ostrich or emeu. Only two of the

free distal phalangeal extremities are preserved. The shaft is broken, showing that its interior is filled with cancellous tissue. The free extremities are remarkable for the great inferior extent of the articular trochlear face. The median is strongly grooved with an obtuse excavation, and the lateral or bordering ridges are equal and rounded. The groove is continuous with the superior surface, but not with the inferior. There the convergent lateral ridges inclosing the open groove, terminate in an abrupt elevation above the adjacent surface of the shaft. The sides at this point are concave. The inner free condyle has an oblique articular face, the external ridge dropping away internally as in many birds, and produced beyond the inner ridge, distally. The articular face becomes then a part of a spiral, and is little grooved above, but strongly grooved medially. The vertical diameters of the sides differ, the inner being much greater, and both are concave. A strong foramen pierces the shaft just within the point of junction of the inner and medial free extremities.

Measurements.		m.
Transverse diameter of proximal end of tarsometatarsus		·100
Antero-posterior do. (partly inferential)		·070
Interval between penetrating foramina on anterior face shaft		·017
Median distal condyle	Long diameter	·050
	Vertical diameter	·048
	Transverse diameter	·040
Internal distal condyle	Long diameter	·037
	Vertical diameter	·040
	Transverse diameter	·031

The large size and wide separation of the penetrating foramina, and the thin internal edge with suturul articular facet, distinguish this form as distinct from any of the genera of Struthionidæ and Dinornithidæ. It is therefore named *Diatryma gigantea.*

7. *Fifth Annual Report of the Geological Survey of Indiana made during the year* 1873; by E. T. Cox, State Geologist. 494 pp. 8vo, with maps.—This volume contains a general report by Professor Cox; a report on Clarke and Floyd counties, by W. W. Borden; on Warren, Lawrence, Knox, and Gibson counties, by Mr. John Collett; and observations in DeKalb and other counties, by G. M. Levette.

Footprints of Labyrinthodont character, found by Mr. Collett near the base of the Coal Measures in Warren county, are described and figured; they are 1¼ to 1½ inches long, and 1 to 1¼ broad, all 5-toed, and the stride is three inches. The species is named by Prof. Cox *Collettosaurus Indianensis.*

A *tripoli*, from "pockets" in the cherty limestone above Coal K, in Dubois county consists, according to Dr. J. Gardner, almost wholly of spicules of sponges; and in one cherty nodule from the same vicinity, there was, in a cavity near its center, a slight network of the glassy filaments of the sponge, about which concretion took place, indicating, as stated by Dr. Gardner, that the hornstone nodules found in the cherty beds correspond each to a fossil sponge.

Several *terraces* exist on the border of Lake Michigan, near Michigan City, the highest of which—the fifth—is elevated 225 feet above the lake. The fourth is 95 feet above the same level, and contains much coarse gravel.

8. *Fossil Plants of the Coal-measures of Terrera, in the Atacama district, Chili.* (Bull. Soc. Geol. de France, III, iii, 572, 1876.)—The plants are Jurassic, of the Lower Lias or Rhætic beds, and included *Jeanpaulia Münsteriana* Presl., *Angiopteridium Münsteri* Gœpp., a *Pecopteris* (*P. Fuchsi*), near *P. Gœppertiana.*

III. Botany and Zoology.

1. *Sensitive Stigmas as an aid to cross fertilization of Flowers;* by Prof. W. J. Beal, (Proc. Amer. Assoc., Buffalo.)—The flowers of *Martynia proboscidia*, a plant sometimes raised in our gardens for pickles, has flowers drooping at an angle of about forty-five degrees. At the opening on the upper side are two flat stigmas, curved back away from each other, exposing the surface which is sensitive to pollen. Farther on are the four anthers, side by side, with their cells placed end to end. The opening is just large enough to take in the humble bee, or the common hive bee will do as well.

I have been carefully watching the Martynia plants for several weeks, since they have been in flower, every day and at nearly all hours and sometimes several times a day. I have the plants in four places, two of which are beds about four feet by ten. They are among other beds of flowering plants which are freely visited by various kinds of insects. I felt quite sure that the humble bee transferred pollen on his back, because I found the stigmas covered with pollen and closed before night each day. I could not contrive how else the pollen could be transferred. I began to fear I should have to give it up. But, one morning about nine o'clock, I saw a single humble bee pass from flower to flower on nearly every specimen on one patch of plants. The visit lasted only a few moments. All parts are quite sticky with glutinous hairs which seem to annoy the bees very much. I have never seen but one bee on the flowers of Martynia; she alighted on the spotted, showy part of the corolla, and crawled, first hitting the stigmas.

One of the most interesting points is now to be explained. The stigmas are sensitive to the touch, and close up in five to ten seconds; often before the insect is ready to back out of the flower. If they are not quite closed at that time, the bee shuts them by pushing her back against the back of one of the stigmas. The lower lobe of the flat stigma next to the bee's back is the larger. No pollen can be left as the insect retreats. A cross of pollen is usually certain. If not very freely dusted with pollen the stigmas open again in about fifteen minutes; if well dusted I have known them to remain closed afterward.

The single flat stigma of the iris, one on each of three sides of the flower, has often been shown to be sure of cross-fertilization, if

fertilized at all. Some years ago I examined hundreds of specimens as they were fertilized by bees. The stigma closes up after it is covered with pollen. It is sensitive to the touch; perhaps only slowly, but I think it moves back in a few seconds. I have examined no specimens lately with special reference to this point. The stigmas of *Mimulus ringens* are curved out like those of the Martynia, and project beyond the anthers. I have seen small native Hymenoptera visit this plant, always crawling in with the back down, although Mühler says in personate flowers the bees always get their backs up as they pass in. The stigmas of this *Mimulus* are slowly sensitive, closing in a few moments after they are touched or well supplied with pollen. The stigmas of the *Mimulus luteus* and *Mimulus moschatus*, and likely other species, close very quickly after being touched. *Tecoma radicans* and *Tecoma grandiflora* and probably other species, are very much like Martynia in the peculiarities mentioned. I have not lately had the opportunity of examining the flowers of the Bigonia or Catalpa but I shall expect to find them cross-fertilized in the same way as Tecomia aided by sensitive stigmas. *Utricularia vulgaris*, one of our larger common bladderworts, has a yellow irregular flower which considerably resembles that of the snap-dragon. The stigmas act much as in Martynia. The lower lip of the stigma is much the larger and when touched bends up close against the upper lip of the corolla just under an arch-like projection. The other nice adaptions for securing cross-fertilization are rather complicated and need not be given at this time.

Pinguicula is quite similar in structure to the Utricularia and is likely sensitive in its stigmas, and fertilized in the same way. All the stigmas which I have seen that are sensitive, stand with one side toward the space visited by insects, and if there are two together, the larger stigma comes next to the body of the insect. —*Buffalo Courier*, Aug. 25, 1876.

2. *On the theory of Evolution;* by Prof. COPE. (Proc. Acad. Nat. Sci. Philad., Feb., 1876.)—Prof. Cope gave a history of the progress of the doctrine of evolution of animal and vegetable types. While Darwin has been its prominent advocate within the last few years, it was first presented to the scientific world, in a rational form, by Lamarck of Paris, at the commencement of the present century. Owing to the adverse influence of Cuvier, the doctrine remained dormant for half a century, and Darwin resuscitated it, making important additions at the same time. Thus Lamarck found the variations of species to be the primary evidence of evolution by descent. Darwin enunciated the law of "natural selection" as a result of the struggle for existence, in accordance with which "the fittest" only survive. This law, now generally accepted, is Darwin's principal contribution to the doctrine. It, however, has a secondary position in relation to the *origin* of variation, which Lamarck saw, but did not account for, and which Darwin has to assume in order to have materials from which a "natural selection" can be made.

The relations exhibited by fully grown animals and plants with transitional or embryonic stages of other animals and plants, had attracted the attention of anatomists at the time of Lamarck. Some naturalists deduced from this now universally observed phenomenon, that the lower types of animals were merely repressed conditions of the higher, or in other words, were embryonic stages become permanent. But the resemblances do not usually extend to the entire organism, and the parallels are so incomplete, that this view of the matter was clearly defective, and did not constitute an explanation. Some embryologists, as Lereboullet and Agassiz, asserted that no argument for a doctrine of descent could be drawn from such facts.

The speaker, not adopting either view, made a full investigation into the later embryonic stages, chiefly of the skeleton of the Batrachia, in 1865, and Prof. Hyatt, of Salem, Mass., at the same time made similar studies in the development of the Ammonites and Nautili. The results as bearing on the doctrine of evolution were published in 1869 (in "The Origin of Genera"). It was there pointed out, that the most nearly related forms of animals do present a relation of repression and advance, or of permanent embryonic and adult type, leaving no doubt that the one is descended from the other. This relation was termed *exact parallelism*. It was also shown, that, if the embryonic form were the parent, the advanced descendant was produced by an increased rate of growth, which phenomenon was called *acceleration;* but that, if the embryonic type were the offspring, then its failure to attain to the condition of the parent is due to the supervention of a slower rate of growth; to this phenomenon the term *retardation* was applied. It was then shown that the *inexact parallelism* was the result of *unequal* acceleration or retardation; that is, acceleration affecting one organ or part more than another, thus disturbing the combination of characters which is necessary for the state of *exact parallelism* between the perfect stage of one animal and the transitional state of another. Moreover, acceleration implies constant addition to the parts of an animal, while retardation implies continual subtraction from its characters, or atrophy. He has also shown (Method of Creation, 1871), that the additions either appeared as *exact repetitions* of preëxistent parts, or as *modified repetitions*, the former resulting in simple, the latter in more complex organisms.

Professor Hæckel, of Jena, has added the keystone to the doctrine of evolution in his Gastræa theory. Prior to this generalization, it had been impossible to determine the true relation existing between the four types of embryonic growth, or, to speak otherwise than that they are inherently distinct from each other. But Hæckel has happily determined the existence of identical stages of growth (or segmentation) in all of the types of eggs, the last of which is the *gastrula;* and beyond which the identity ceases. Not that the four types of gastrula are without difference, but this difference may be accounted for, on plain principles. In 1874, Hæckel, in his "Anthropogenie," recognizes the importance of the

irregularity of time of appearance of the different characters of animals during their period of growth, as affecting their permanent structure. While maintaining the view that the low forms represent the transitional stages of the higher, he proceeds to account for the want of exact correspondence exhibited by them at the present time, by reference to this principle. He believes that the relation of parent and descendant has been concealed and changed by subsequent modifications of the order and appearance of characters in growth. To the original simple descent he applies the term *palingenesis;* to the modified and later growth, *cœnogenesis.* The causes of the change from palingenesis to cœnogenesis, he regards as three, viz: acceleration, retardation, and heterotopy.

It is clear that the two types of growth distinguished by Prof. Hæckel are those which had been pointed out by Prof. Cope in "The Origin of Genera," as producing the relations of "exact" and "inexact parallelism;" and that his explanation of the origin of the latter relation by acceleration or retardation is the same as that of the latter essay. The importance which he attaches to the subject was a source of gratification to the speaker, as it was a similar impression that led to the publication of "The Origin of Genera" in 1869.

It remains to observe that the phenomena of exact parallelism or palingenesis, are quite as necessarily accounted for on the principle of acceleration or retardation, as are those of inexact parallelism or cœnogenesis. Were all parts of the organism accelerated or retarded at a like rate, the relation of exact parallelism would never be disturbed; while the inexactitude of the parallelism will depend on the number of variations in the rate of growth of different organs of the individual, with additions introduced from time to time. Hence it may be laid down, that *synchronous acceleration* or *retardation* produces exact parallelism, and *heterochronous acceleration* or *retardation* produces inexact parallelism.

In conclusion, it may be added that acceleration of the segmentation, the protoplasma or animal portion of the primordial egg, or retardation of segmentation of the deutoplasma or vegetative half of the egg, or both, or the same relation between the growth of the circumference and center of the egg, has given rise to the four types which the segmentation now presents.

An analysis of the laws of evolution may be tabulated as follows:—

Acceleration, which proceeds by { Exact repetition. / Modified repetition. / Heterotopy.

Retardation, which proceeds by { Exact atrophy. / Inexact atrophy (or senility),*

and each of the methods may be either of *Exact parallelism*, the product of *Palingenesis*, which is *synchronous;* or *Inexact parallelism*, the product of *Cœnogenesis*, which is *heterochronous.*

3. *Mimicry in Butterflies explained by Natural Selection;* by S. H. SCUDDER. (Proc. Amer. Assoc., Buffalo.)—Fritz Müller,

* So called by Professor Hyatt.

whose contributions to science are always worthy of especial attention, endeavors in a recent German periodical to show how the phenomena of mimicry in butterflies may be explained by the theory of natural selection. He bases his inquiries upon the species of Leptalis found in southern Brazil; and although, as will appear below, he adduces reasons for believing the primitive stock to have been banded, and not, like most of the family to which the genus belongs, simple white butterflies, he commences by showing how even such an extreme change could be wrought out by the survival of the fittest in the struggle for existence. "Should," he remarks, "the first unimportant variations from the original white color (of the Pierids) be useful only in attracting to their possessors, at a little shorter distance, the attention of enemies flying constantly overhead, they would become more and more useful, and cause their possessors to become continually more abundant in proportion to the type, they could therefore serve as the basis for the gradual formation of a resemblance fit to deceive even the sharp eyes of birds scanning the swarms of Ithonias (the butterflies imitated by some Leptalids) for booty." Further on he asserts that "the acceptance, as the starting point in the origin of mimicry by natural selection, of a resemblance having its beginning at such a distance, can scarcely be shaken by a single known case. It should moreover not escape attention that the sharpsightedness of enemies is itself also a quality at first gradually acquired in the struggle for existence, and one which must increase from the very fact that by protective coloring, mimicry, &c., the persecuted species escapes the less sharp-sighted pursuer. This ever increasing sensitiveness and sharpsightedness of the pursuer on the one hand explains the wonderful completeness of many natural imitations, and, on the other, makes the acceptation of an originally very slight resemblance the less hazardous."

Fritz Müller insists, as all writers on the subject have done, upon the similar geographical distribution of the imitating and the imitated species, as a necessary concomitant of mimicry, but instead of believing, with the other authors, that the Leptalids have become poor flyers in their imitation of the feeble-winged Ithonias; he holds that the wretched powers of flight possessed by the species of Leptalis have been the very cause of mimicry; the insects needed mimicry the more the poorer flyers they were. Mimicking species, of course, stand between their original type and the mimicked species; and, since mimickry is often confined to the female, we should expect in such cases to find the following series: original form, male of mimetic species, female of same. Species mimicked. In his vicinity, Müller has found five species of Leptalis, of which only four are common and discussed by him. Of these four, *Leptalis melia* mimics nothing; all the other three are imitative species, and mimic distinct groups of butterflies; *Leptalis astynome*, resembling a Heliconian-like Danaid, *Mechanitis Lysimnia;* another, which he calls *Leptalis thalia*, mimicking an Acræan, *Acræa thalia*, so closely that Müller at first supposed it to be an Acræan;

and the last, *Leptalis melite*, bearing a close resemblance to the female of one of its own family, *Leptoneura Lycinunia.—Buffalo Daily Courier*, Aug. 25, 1876.

4. *A Preliminary Note on Menopoma Alleghaniensis of Harlan;* by A. R. GROTE, (Proc. Amer. Assoc., Buffalo, 1876.)—I have been able to examine nearly one hundred specimens of the Menopoma Alleghanense, the aquatic salamander living in the tributaries of the Mississippi, taken in the months of July and August in the Alleghany river, at Olean, N. Y. The object of the present communication is to record the fact that the more reddish unicolorous specimens, which have been described as a distinct species under the name of *fuscum* by Holbrook, and which are retained as a distinct species by Prof. Cope in his check list, cannot be considered as a different species from the spotted specimens from which the original description seems to be drawn. We have one species in the tributaries of the Ohio and Mississippi, and not two. The larger, and apparently often the female specimens, are referable to Holbrook's name. Between the two there seems to be all possible grades, and from the same locality, although the two extremes are more numerous, and, at first sight, readily picked out.

I have also to record the fact that the animal sheds a transparent membrane, which I believe is the exterior layer of the skin. While observing this fact in the aquarium of the Buffalo Society of Natural Sciences, Prof. S. W. Garman and myself were able to find an almost complete skin, all the feet and the toes being readily perceived while floating and unfolding it in the water. This same skin was observed at first gathered in the mouth of the animal, which was apparently in the act of swallowing it. This last observation is interesting, since a similar habit had been previously observed in the case of the common toad. All individuals of the Menopoma that I have observed have in the water an intermittent swaying motion from side to side. While I have not been able to verify the conjecture, this movement of the body may be connected with the effort of the animal to get rid of its skin. On the other hand it may be a movement to attract the sexes, or connected with the breeding period.

In *Dactylethra* and *Cyclorhamphus* Prof. Garman has observed a similar shedding of the skin. We may predict that the same thing occurs in the other more exclusively aquatic forms *Necturus tetradactylus* (*Menobranchus lateralis* of authors), *Amphiuma*, *Siren*, and also in the forms that take to the land, as *Amblystoma*, *Plethodon*, *Desmognathus*, and *Diemyctylus*, as well as in *Megalobatrachus* of Japan.

I have to record also the fact that females opened on August 21st, contained well developed eggs attached by a membrane to the ovary.

I finally wish to record the important fact that the eggs are deposited in August. (I exhibit one taken from the aquarium this morning, Aug. 30th, 1876.) The yolk is seen floating freely in a glairy fluid, enveloped in a membrane similar to that containing

the albumen in a bird's egg inside the shell. The eggs are laid in a connected string and impregnations probably occur as they are extruded. The egg takes in water by endosmosis.

The Menopoma frequents the muddy banks of the river, in which to secrete its eggs. In external appearance there is at this time a change, and we may say that the animal puts on its "marriage dress." The tail broadens and there is a plaited extension of the skin, along the sides of the body. The *Menopoma* is nocturnal in its habits.

5. *The Entomological Section of the American Association, Buffalo, N. Y. Address of* Dr. LeConte, *President of the Section.*—After noticing some of the evidences of progress in new publications, etc., Dr. LeConte added:

I would gladly stop here, but a sense of duty to science, and my obligation to you alike forbid silence. I have to speak of a subject of a disagreeable nature.

It is concerning the efforts made by you and other members of the Association at the last meeting at Detroit, to procure the appointment of a Commission for the protection of Agriculture against noxious insects: this Commission to be composed of properly informed men of science, and chosen under such circumstances as would prevent the influence of political bias, or personal favoritism. If I do not fatigue your memory too much, you will recollect the memorials that were so extensively signed, in relation to this subject; copies of which memorials are again before you. These memorials were extensively circulated at the West, and were signed by many of the most influential bodies for the promotion and protection of agriculture in that region. During the winter these memorials were sent to Congress, in the expectation that some proper legislation would follow. One of the Senators, in fact, introduced a bill which seems to have been very carefully considered, and indeed bears upon its face some evidence of scientific guidance. This bill provided for the appointment of three Commissioners for five years: the Commissioners to be nominated by the Council of the National Academy of Sciences to the Secretary of the Interior. This bill, having been referred to the Committee on Agriculture, was returned so altered in form as to provide for one Commissioner, to be appointed by the Department of Agriculture, the very enemy and incubus from which the western agriculturists specially desired to be relieved.

The bill in this form passed the Senate, several of the members taking occasion in the discussion which preceded the passage, to talk to the demonstration of their own ignorance of the subject. However, this discussion has been already so severely commented upon in several of the newspapers of the Mississippi valley, that it is quite unnecessary for me to add anything farther, except the hope that the Legislature which chooses the successors of those Senators will have men of better education and higher intelligence offered to them as candidates for the position.—*Buffalo Daily Courier*, Aug. 25, 1876.

6. *Manual of the Vertebrates of the Northern United States;* by D. S. JORDAN. 12mo, 342 pp., no figures. Chicago: 1876. (Jansen, McClurg & Co.)—To collectors and others who chiefly desire to ascertain the names of species, this will doubtless prove to be a very convenient and useful work, especially if they have already acquired considerable familiarity with the subject by the use of more elaborate works. But it will prove of little value as a genuine Natural History of our vertebrates. Inasmuch as works of this class naturally tend to foster the already too prevalent idea that the study of "zoology" and "botany" means only, or chiefly, the learning of the names and habits of animals and plants, they may, in many cases, do more to hinder than to help the true progress of these sciences. In the present work we find little more than the shortest and most meagre descriptions of the species, usually without any reference whatever to habits, while the characters of the genera cannot be ascertained, in most cases, except by the use of "analytical tables," which are, for the most part, highly artificial.

The descriptions of the families and orders are likewise very brief and technical. At most, it should be regarded only as a convenient key or index to the names and classification of the species included in it. But on this very account, the absence of synonyms and of all references to more important works, in which the species are fully described or figured, is a very serious defect, which renders it far less useful than it otherwise might have been. A mere list of the numerous important works from which the author has compiled his book would have been of far more use to most students than any other part of the book of similar extent. Although the author, in the preface, admits that he has compiled his materials from numerous authors, he seldom indicates, in the body of the work, from what special work, or even from what author, a statement or description has been borrowed. The reliability of such compilations depends so directly upon the works used in compilation, that some indication should always be given of the source of the statements, and this could easily have been done without materially increasing the size or cost of the book. The copious index and glossary at the end are good features.

There are, as might have been anticipated, many inaccuracies, and also some important omissions of species. The genus *Neosorex*, of which a species (*N. palustris*) was described by the writer from Maine and Massachusetts,* and by Prof. Cope, from New Hampshire, is not mentioned at all. There are but two species of *Sorex* mentioned, while there are certainly three, and perhaps four species in New England. *Blarina angusticeps*, a well marked form, is also omitted. The American bears are all reduced to one species, in accordance with Mr. J. A. Allen's former views, which, however, he has since discarded, as noticed in the last number of this Journal. Among the fishes, where there is some original matter, the author has, in some genera, rejected or ignored many species

* Proceedings Boston Soc. Natural History, vol. ix, p. 164, 172, 225, 1862. See also *N. fimbripes* (Bachman, sp.) from Pennsylvania.

recognized by other writers, which is an easy, if not satisfactory, way, of jumping difficult subjects. This is especially the case in the Salmonidæ and Catostomidæ. v.

7. *The Five Senses of Man;* by JULIUS BERNSTEIN. International Scientific Series. 301 pp., 91 wood-cuts. New York: 1876. (D. Appleton & Co.)—In this work the author has presented very clearly, and in a pleasing manner, the more important facts and theories concerning this interesting subject, together with statements of the numerous observations and experiments recently made, relating to the senses. As many of these recent investigations are not included in the text-books and treatises ordinarily used, this book will be of general interest. v.

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *On the fall of a Meteorite in Kansas City, Missouri, in June*, 1876; by JOHN D. PARKER. (Letter to Editors dated Kansas City, Mo., Aug. 2, 1876.—On June 25, 1876, between the hours of nine and ten in the morning, a small meteorite fell upon the tin roof of Mr. Isaac Whittaker's business house, No. 556 Main street, Kansas City, Mo. The meteorite came down with sufficient force to cut a hole in the tin roof on the front part of the house near an open window, but not passing entirely through the tin, it bounded back a few feet and lay on the roof. Mrs. Baker, who occupies rooms in the front part of the house in the second story, and Mrs. Whittaker were standing near the window when the meteorite fell, and heard the sharp concussion when it struck the roof. Mrs. Baker immediately picked up the meteorite as it lay near her on the roof, but dropped it again, finding it too hot to retain it in her hand.

The meteorite is a plano-convex specimen, about one and three-quarter inches in diameter, and about one-third of an inch in thickness. The outside or convex surface possesses the usual crusted appearance, while the inside or plane surface differs from ordinary meteorites in possessing the appearance of sulphuret of iron, subjected to some degree of heat, instead of nickeliferous iron. One might easily infer that the meteorite was shaled off from a large bolide that passed over the city at that time. As it fell in the city, I have named it the Kansas City Meteorite. It has not been subjected to chemical analysis.

2. *American Association for the Advancement of Science, at Buffalo.*—The meeting of the Association at Buffalo opened on Wednesday, on the twenty-third of August. Prof. WILLIAM B. ROGERS was the President of the meeting. The address of the retiring President, Mr. J. E. HILGARD, of the Coast Survey, treated of the recent progress in the department of Geodesy, and especially of the work accomplished in the United States. There were addresses also by the Vice-Presidents of the sections, Prof. C. A. YOUNG giving a review of recent Astronomical progress, Prof. E. S. MORSE, of work done in North America in connection

with the subject of Evolution; and Prof. G. F. BARKER treating of "the Atom and the Molecule."

The number of members present was large, and the hospitality of the citizens of Buffalo unbounded. Besides other entertainments, there was, without expense to the members, an excursion on Saturday to Niagara Falls, where a generous lunch was furnished them by Mr. John L. Bush at his mansion; and on the following Wednesday, over the Chautauqua Lake, to Jamestown, seventy miles. Between four and five hundred persons went on these excursions.

A number of distinguished foreign men of science were present —among them Prof. Huxley; Prof. Otto Torell, Dr. J. Lindahl and J. Nordström, of Sweden; Prof. E. H. von Baumhauer, of Haarlem; Mr. W. Sagel, of Vienna; R. Kœnig, of Paris; and Signor Castellani, of Rome. Prof. Huxley was received with a vote of welcome amid much applause.

The officers elected for the next meeting of the Association are as follows: Prof. SIMON NEWCOMB, President; Prof. EDWARD C. PICKERING, Vice-President of the Physical section; Prof. O. C. MARSH, Vice-President of the section of Geology and Natural History; Prof. N. T. LUPTON, Chairman of the Chemical subsection; Prof. DANIEL WILSON, Chairman of the subsection of Anthropology; R. H. WARD, Chairman of the subsection of Microscopy; A. R. GROTE, General Secretary; F. W. PUTNAM, Permanent Secretary; WM. S. VAUX, Treasurer. The Association adjourned to meet in 1877, at Nashville, Tennessee, on the last Wednesday of August.

The following is a list of the papers read at the meeting or accepted for reading.

I. *Physical Section.*

On the practicability of cooling the air of buildings during hot weather; S. NEWCOMB.

Note on the radiometer, T. C. MENDENHALL.

Certain new constructions in graphical statics, H. T. EDDY.

Spectroscopic observations on the sun's rotation, C. A. YOUNG.

On some recent spectroscopic observations of the zodiacal light, A. W. WRIGHT.

Volatilization of metals by the electrical discharge, id.

On Kent's table of one-quarter squares of numbers, S. J. COFFIN.

A new fundamental method in graphical statics, H. T. EDDY.

On the Iowa weather stations, G. HINRICHS.

Phenomena produced by the union of two sounds, R. KŒNIG.

Discussion of the general principles of construction of ordinary and perfect magic squares, J. D. WARNER.

Physics of the Gulf of Mexico and the Mississippi River, C. G. FORSHEY.

Solar influence on the degradation of soils by aqueous action, T. MCWHORTER.

The specific gravity of lead, P. SCHWEITZER.

Co-ordinate surveying, H. F. WALLING.

Some remarks on the use and interpretation of particular integrals which satisfy general differential equations expressive of dynamic problems, suggested by Laplace's dynamic theory of the tides, J. G. BARNARD.

Determinations of subjective temperature, J. W. OSBORNE. The accurate graduation of thermometers by comparison, id. Experiments on the gyration of liquid masses in rotation, id.

Observations on the diurnal variation in the humidity of the air, H. HAMBERG.

On the increase of index of refraction accompanying change of temperature, T. C. MENDENHALL.

Dielectric polarization, E. ROOT.

Essay on the molecular character of steam, S. M. ALLEN.

A tide gauge for use in cold climates, J. M. BATCHELDER.

Meteorites of Amana, Iowa Co., Iowa, G. HINRICHS.

On the distribution of errors in numbers written from memory, F. E. NIPHER.

Account of a series of experiments on the refrigeration of air by expansion, P. H. Van der WEYDE.

On the combined compression and stage-forceps carrier, R. H. WARD.

Proposed method of evolution, J. D. WARNER.

Exhibition of capillary coke, from Tracy City, Tenn., N. T. LUPTON.

Relative market prices of gold and silver, and their influence on the metallic monetary standard of the United States, E. B. ELLIOTT. Prices of the bonded securities of the United States and the corresponding rates of interest realized to investors, id.

II. *Section of Geology and Natural History.*

On the mode of extrusion of the ova in Limpets, W. H. DALL.

On the origin of kames or eskers in New Hampshire, W. UPHAM.

Some new points regarding the tongue of Picus viridis, J. LINDAHL.

On the geology of Eastern Pennsylvania, T. S. HUNT.

Note upon the geological position of the serpentine limestone of Northern New York, and an inquiry regarding the relations of this limestone to the Eozoon limestone of Canada, J. HALL.

On the plastidule hypothesis, L. ELSBERG.

On self-fertilization and cross-fertilization in flowers, T. MEEHAN. On graft hybrids, id.

The water-lime group of Buffalo, A. R. GROTE and W. H. PITT.

On the provisional hypothesis of Pangenesis, W. K. BROOKS.

On a new species of Argulus, A. H. TUTTLE. Notes on the myriapods of Ohio, id.

The slight morphological value of natural attitude and numerical composition, B. G. WILDER. Notes on the brains of fish-like vertebrates; myxinoids, sharks and skates, chimæra, teleosts, id. Notes on the North American Ganoids, id.

The origin and mode of formation of the Great Lakes, J. S. NEWBERRY.

The relations of the rocks of Ohio to those of Pennsylvania and New York, id.

Principal characters of American Pterodactyles, O. C. MARSH.

Note on the pitchstones of Arran, F. A. GOOCH.

On *Sycotypus canaliculatus* Linn., F. W. SIMONDS.

A brief comparison of the butterfly faunas of Europe and eastern North America, with hints concerning the derivation of the latter, S. H. SCUDDER.

On the reciprocal relations of certain genera of articulated brachiopods, W. H. DALL.

New facts relating to *Eozoön Canadense*, J. W. DAWSON.

On the siphon of Endoceras, a genus of chambered shells, A. WINCHELL.

On the post-glacial history of Sequoia gigantea, J. MUIR.

Variation in color in animals, S. W. GARMAN.

Description of new fungus on the leaves of the pear tree, W. H. SEAMAN.

The edible crab of Maryland, *Callinectes hastatus* (Ordway), P. R. UHLER.

Phyllotaxis of cones, W. J. BEAL. Can the Unios see? id. Cross-fertilization of the apple blossoms, id. Sensitive stigmas as an aid to cross-fertilization of flowers, id.

Biological notes on the army worm (*Leucania puncta* Haw), C. V. RILEY.

A preliminary note on *Menopoma Alleghaniensis* of Harlan, A. R. GROTE.

On the origin of mineral veins, C. WHITTLESEY.

A supplement to the glacial theory, W. C. KERR.

Evidences in Boone Co., Ky., of glacial or ice deposits of two distinct and widely distant periods, G. SUTTON.

On the burial place of the Yorkshire Mastodon, discovered in Broome Co., N. Y., T. B. COMSTOCK. Some unexplained phenomena in the Geyser Basins of the Yellowstone National Park, id. The "two-ocean water," the union of the Atlantic and Pacific Oceans in the Rocky Mountains, id.

III. *Subsection of Chemistry.*

The relationship of structure, density and chemical composition in steel, J. W. LANGLEY.

On the limit of reliability in the indirect estimation of sodium and potassium chlorides, H. W. WILEY. Some modified forms of apparatus; flue with artificial draft, flue with artificial draft and air bath, apparatus for sugar and fat extraction, id. Some indigenous Indiana woods, their specific gravity, per cent of ash in wood and bark, id.

On the chemical composition of a saline efflorescence occurring at Goat Island, E. W. MORLEY.

A note upon the rocks of the Galapagos Islands, F. A. GOOCH.

On the chemical composition of Pennsylvania petroleum, S. P. SADTLER.

Contribution to the chemistry of hydrogen, A. R. LEEDS.

Upon the reduction of silver at ordinary temperatures in the presence of free nitric acid, id.

On a siliceous deposit from the interior of a hollow mass of limonite, with observations on the molecular movements of finely divided matter, N. T. LUPTON.

On the so-called alkali of the western plains, B. S. HEDRICK.

On the analysis of milk, E. H. v. BAUMHAUER.

Notes of a mineralogical tour in Western North Carolina, made under the auspices of the State survey, A. A. JULIEN and H. C. BOLTON.

A sugar analysis, A. SPRINGER.

Action of moderate heat on bituminous coal, E. T. COX.

Dissociation of phosphorus in the blast furnace, W. H. CHANDLER and E. H. BAILEY. Nitrates in natural waters and in Lechauweki spring water, id. Determination of nitric acid, id.

IV. *Subsection of Microscopy.*

Results of measurements of eleven of Möller's Diætomaceen Probe-platten, E. W. MORLEY.

Micrometric measurements of rulings on glass, by Mr. ROGERS.

Micrometric measurements of rulings on glass, by Mr. RUTHERFORD.

Results obtained by double staining of muscular tissue of Amphiura with picric acid and carmine, G. BEATTY.

Simple means of adopting the binocular microscope to defects in the eye, W. H. BULLOCK.

Remarks on some American contributions to the development of the modern microscope, R. H. WARD.

On a new system of finder for the microscope.

On a few simplifications of the polarizing and of the spectroscopic microscope.

On some modifications and special attachments to the microscope for chemical research, P. H. VAN DER WEYDE.

V. *Subsection of Anthropology.*

Peculiarities of the femora from tumuli in Michigan, H. GILLMAN. Investigation of the burial ground at Fort Wayne on the Detroit river, Michigan, id. Some observations on the orbits of the crania from mounds, id.

The international symbols for charts of prehistoric archæology, O. T. MASON. The scope of anthropology, and the classification of its materials, id. Archæological collections from Porto Rico, id.

The Iroquois phratry, L. H. MORGAN. The Iroquois gens, id. The Iroquois confederacy, id.

Etruscan and Greek art in Jewelry, and its revival, A. CASTELLANI.

Hybridity and absorption among the races of the New World, D. WILSON.

On the mythology of the North American Indians, J. W. POWELL.
Brain-weight and size in relation to the relative capacity of races, D. WILSON.
On some fragments of pottery from Vermont, G. H. PERKINS.
On the ancient and modern Pueblo tribes of the Pacific slope of the U. S., E. A. BARBER.
The mood of the verb in conditional clauses, ISAAC B. CHOATE.
The museums of industrial art in Austria, HEINRICH FRAUBERGER.
The archæology of Europe and America compared, S. D. PEET. On the state of society in the Primitive age, id.

3. *Geographical Distribution of Plants and Animals;* by C. PICKERING, Wilkes' U. S. Exploring Expedition, author of the Races of Man. Part II, Plants in their wild state. 524 pp. 4to, with several colored maps. Salem, Mass. (Naturalist's Agency.) —This work, completing Dr. Pickering's Report on the Geographical Distribution of Plants and Animals, is the result of extensive personal observation about the world as well as of much study. It is a large storehouse of facts, on a subject of general interest, gathered with great labor and fidelity. It gives observations with regard to the characteristic plants and predominant botanical features of all the various islands and continental regions visited by the Exploring Expedition under Captain (now Admiral), Wilkes, and also many collateral facts on climate, topography, scenery, etc., that came under the author's observation. The text is illustrated by maps of the world, presenting by colors the conclusions arrived at by the author.

4. *Proceedings of the Davenport Academy of Natural Sciences.* Vol. 1, 1867–1876. 284 pp. 8vo, with 35 plates. Davenport, Iowa, 1876.—This first volume of the Proceedings contains a number of very valuable papers on mounds and mound-builders, by R. J. Farquharson, M.D., W. H. Pratt, A. S. Tiffany, C. Lindsley, and J. D. Putnam, with 34 plates, full of figures representing the structure of mounds, flint and other stone implements, pipes of the form of birds, frogs, and other animals, woven cloth, copper axes, awls, beads, and ear-drops, silver ear-drop, bone knives, pottery, skulls, etc., from different mounds, illustrating a paper by Dr. Farquharson. There are also Zoological articles by J. D. Putnam; Botanical notes by Dr. C. C. Parry; and lists of species of plants, and of land and fresh-water shells, of Coleoptera, Lepidoptera, Hymenoptera, of the vicinity of Davenport, besides other papers.

OBITUARY.

EBENEZER S. SNELL, of Amherst College, Massachusetts, Professor of Mathematics and Natural Philosophy, died, September 18th, aged seventy-five years.

Prof. CHARLES DAVIES, author of various mathematical works, a graduate of West Point of distinction, and from 1857 to 1867 Professor of Mathematics in Columbia College, died September eighteenth, in his seventy-ninth year.